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Gender differences in vascular stiffness indicators and daily blood pressure profile in patients with arterial hypertension and depressive disorders

Aim	To study gender-related characteristics of vascular wall stiffness (VWS), central blood pressure (CBP), and BP diurnal profile in patients with arterial hypertension (AH) and depression.
Material and methods	This prospective, noninterventional study enrolled 161 patients, including 98 patients with AH and depression (50 (51%) men and 48 (49%) women) and 63 patients with AH without depression (32 (50.8%) men and 31 (49.2%) women. The 24-h BP monitoring (24-h BPM) with a BPLab Vasotens hardware system was performed for all patients. The following indexes were evaluated: mean diurnal, mean daytime, and mean nighttime systolic and diastolic BP (SBP and DBP); daytime and nighttime SBP and DBP time index; SBP and DBP variability; and suite of metrics characterizing VWS and CBP. Depression was diagnosed with the Hospital Anxiety and Depression Scale (HADS) and the Zung Self-Rating Depression Scale. Statistical analyses were performed using the STATISTICA 12 software.
Results	In the patient group with AH and depression, practically all indexes of 24-h BPM were higher for men than for women ($p<0.05$). Most 24-h BPM parameters did not differ in groups of men and women without depression. Independent of gender, 24-h BPM parameters were significantly higher in patients with both AH and depression than in AH patients without depression. Adverse changes in major indexes of VWS and CBP, were more pronounced in men than in women with AH and depression ($p<0.05$). Adverse changes in most VWS and CBP indexes were more statistically significant for men with AH and depression than for men without depression.
Conclusion	The presence of depression in men and women with AH was associated with significant pathological changes in both BP diurnal profile and CBP and VWS parameters. Furthermore, adverse changes in indexes were more pronounced for men with depression than for women. The study results should be taken into account in administration of antihypertensive and psychocorrective drug therapy to personalize the treatment and provide not only optimization of diurnal BP profile but also vasoprotection.

Keywords	Arterial hypertension; depression; vascular wall stiffness; gender differences
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The correlation between arterial hypertension (AH) and psycho-emotional disorders, specifically depression, has been a matter of discussion for a long time. Recent studies have confirmed the close relationship between AH and depression, making treatment more challenging [1–3]. Moreover, depression reduces patients' quality of life and is a predictor of adverse outcomes [4].

In AH patients with depression, disruption of blood pressure (BP) circadian rhythm has a major role in cardiovascular complications (CVCs). For example, AH patients with depression are characterized by insufficient reduction of BP at night (non-dipper), which is known to be associated with an increased incidence of stroke, myocardial infarction (MI), and death [5, 6].

However, central aortic pressure (CAP) elevation and several other indicators of arterial wall stiffness (AWS) make a significant contribution to the development of CVD in patients with AH [7, 8]. Given that the combination of AH and depression is not rare, the features of changes in vascular walls and CAP in such cases are now actively being studied. AH patients with psycho-emotional disorders usually have abnormal artery stiffness indicators [9, 10]. The increased risk of stroke/MI in patients with depression and cardiovascular diseases (CVDs) is believed to be largely due

to the negative changes in vascular stiffness and increased CAP [9].

The gender-associated differences in the development and prognostic value of psycho-emotional disorders in AH also need to be mentioned. Depression is diagnosed more frequently in females than males, both in the general population and among patients with AH, coronary heart disease (CHD), and chronic heart failure (CHF) [11]. However, there is contradictory data relating to the severity of depression and its contribution to the development of CVDs in male and female patients. Several studies have shown that depression is closely associated in male patients with the development of AH, and this association is not typical in female patients [12, 13]. Moreover, the prognosis for male patients with depression and CVDs is significantly worse than for female patients [14].

There is little data in the literature on the gender-associated features of changes in the 24-hour profile of BP, CAP, AWS in AH patients with depression. However, the recognition of gender-associated differences in these indicators may contribute to improving drug treatment of both AH and depression in this group of patients.

Aim

To analyze gender-associated particularities of AWS, CAP, and 24-hour profile of BP in AH patients with depression.

Material and methods

The prospective observational study was carried out in the Krasnodar City Clinical Hospital for Emergency Care and Krasnodar Krai Regional Clinical Hospital No. 2. The ethics committee of Krasnodar Krai Regional Clinical Hospital No. 2 approved the study protocol.

The study included 161 patients. 98 AH patients with depression and 63 AH patients without depression who made up the control group. The number of male and female patients was comparable in both groups: 50 (51%) male and 48 (49%) female patients in the group of AH patients with depression; and 32 (50.8%) male and 31 (49.2%) female patients in the group of AH patients without depression. The exclusion criteria were symptomatic forms of CHD, history of MI and/or stroke, CHF FC II–IV according to the New York Heart Association (NYHA) classification, complex rhythm and conduction disorders, type 1 and 2 diabetes mellitus, thyroid diseases, severe somatic pathologies.

Upon inclusion in the study, 30 (30.6%) AH patients with depression received antihypertensive monotherapy [mainly angiotensin-converting enzyme (ACE) inhibitors or angiotensin II receptor blockers (ARBs)], while the remaining 68 (69.4%) patients received a combination of the ACE inhibitor/ARB with thiazide diuretic/dihydropyridine calcium channel antagonist. In the control group, 26 (41.3%) patients received monotherapy with ACE inhibitors or ARBs, while the remaining 37 (59.7%) patients received combination therapy, similar to that in AH patients with depression. It should be noted that antihypertensive drug treatment was comparable in groups of male and female patients, regardless of the presence or absence of depression. It should be noted that patients with depression did not receive corrective psychotherapy (antidepressants, tranquilizers, etc.).

All patients underwent clinical and anthropometric examination. AH was diagnosed with BP ≥140/90 mm Hg following the guidelines of the European Society of Cardiology [15, 16]. Although all patients received 1–2 antihypertensive drugs at the time of inclusion, no one had target BP values. Psycho-emotional disorders were diagnosed by a psychiatrist based on interviews and questioning of patients using the Hospital Anxiety and Depression Scale (HADS) and Zung Self-Rating Depression Scale.

Patients were questioned and examined after signing the informed consent.

All patients underwent 24-hour BP monitoring using a BP Lab device. Mean 24-hour, daytime, and night-time systolic (SBP) and diastolic blood pressure (DBP), SBP and DBP load in the daytime and night hours, SBP and DBP variability, SBP and DBP morning surge (MS), and morning surge rate (MSR). Based on the 24-hour BP index values, the following types of 24-hour BP curves were determined: dipper, non-dipper, night-peaker, and overdipper. Monitoring using the BP Lab Vasotens complex also allowed analyzing the mean 24-hour values of arterial stiffness: reflected wave travel time (RWTT, ms), and RWTT normalized to SBP of 100 mm Hg and heart rate (HT) of 60 bpm (RWTTn), aortic pulse wave velocity (PWVao, m/s) m and PWVao normalized to SBP of 100 mm Hg and HR of 60 bpm (PWVaoN), artery stiffness index (ASI, mm Hg), and ASI normalized to SBP of 100 mm Hg and HR 60 bpm (ASIN), augmentation index (AIx, %), and mean AIx normalized to HR of 75 bpm (AIXN), and ambulatory arterial stiffness index (AASI). CAP indicators were also evaluated: aortic SBP and DBP (SBPao and DBPaao, mm Hg), mean aortic BP (mBPao, mm Hg), aortic pulse pressure (PPao, mm Hg), aortic augmentation index (AIxao, %), and Aix normalized to HR of 75 bpm (AIxaoN), pulse pressure amplification (PPA, %), PPA normalized to HR of 75 bpm (PPAN), left ventricular ejection duration (ED, ms), ED normalized to HR of 75 bpm (EDN), subendocardial viability ratio (SERV, %), and SERV normalized to HR of 75 bpm (SERVN).

The statistical processing of data obtained was carried out using STATISTICA 12.0 (StatSoft, USA). The quantitative variables are expressed as the median and the interquartile range (Me [25th and 75th percentiles]). The

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samples were compared by quantitative variables using the Mann – Whitney U-test for two independent groups. The groups were compared by qualitative variables using the Pearson chi-square test. The differences were considered to be statistically significant with $p<0.05$.

Results

The duration of AH, BP, and HR levels were comparable in male and female patients between the AH groups with and without depression (Table 1). At the same time, female patients were statistically significant older than male patients in both groups, which is important for the estimation of AWS and CAP.

A comparison of the 24-hour BP monitoring data in the group of AH patients with depression showed that almost all indicators of interest were statistically significantly higher in male patients than female patients (Table 2).

The exception was only mean 24-hour HR, daytime SBP and DBP values. These were comparable regardless of the patient's gender. In the group of AH without depression, the mean 24-hour DBP, daytime and night-time DBP were significantly higher in male patients compared to female patients. However, daytime SBP variability was significantly ($p<0.05$) higher in female patients than male patients (Table 2).

At the same time, patients with depression, regardless of gender, had higher mean 24-hour BP monitoring values ($p<0.05$) than patients without depression (Table 2).

The number of male and female patients with such types of 24-hour BP curves as dipper, non-dipper, and night-peaker was comparable in the groups of patients with and without depression (Table 3).

The non-dipper profile prevailed quite predictably in both patient groups (with and without depression). However, the over-dipper 24-hour BP profile was not detected in AH patients with depression. However, this pathological type of the BP curve was present in 3 male and 2 female patients without depression (analysis of DBP variations). Moreover, the non-dipper profile of DBP was detected statistically more often in male and female AH patients with depression rather than those without depression (Table 3). Simultaneously, the night-peaker type of the 24-hour SBP curve was more common in patients without depression ($p<0.05$).

The results of the comparative analysis of AWS and CAP in male and female AH patients with depression are rather important (Table 4).

The values of such key indicators of AWS as RWTT, PWVao, including normalized to HR and BP, and AASI, were statistically significantly worse in male patients showing higher arterial wall stiffness than in female patients. At the same time, female patients had more pronounced ($p<0.05$) negative changes in the augmentation index, including normalized to HR and BP, and aortic augmentation index and aortic pulse pressure amplification than in male patients. Aortic SBP and DBP in male AH patients with depression were higher than in female patients, while aortic mean and pulse pressure levels did not differ (Table 4). However, LV ejection duration was statistically significantly shorter in male patients than female patients. This might be explained by a slightly lower HR in female patients and resulting in longer systole.

It should be noted that patients without depression had similar trends, but they had statistically significant differences only in ASIN, AIx, AIxN, AIxao, AIxaoN, and EDN (Table 4).

It is important that male AH patients with depression were more likely to have severe adverse changes in most of the AWS and CAP indicators compared to male patients without depression ($p<0.05$). The indicators of interest were comparable in female patients with and without depression, except for ASIN, which was statistically significantly higher in patients with depression (Table 4).

The comparative analysis of HADS and Zung scale results in patients with depression showed comparable depression severity in male and female patients. The HADS score allows the presence of anxiety to be determined. The intragroup comparisons showed that the severity of anxiety symptoms in female patients was statistically higher than in male patients: 6 (5–7.5) versus 0.77 (4–0.77).

Table 1. Clinical characteristics of the subjects

Parameter	AH patients with depression		p_1	AH patients without depression		p_2
	Male (n=50)	Female (n=48)		Male (n=50)	Female (n=48)	
Age, years	57 [52; 62]	60 [54.5; 66.5]	0.031	57 [48.5; 64.5]	62 [56; 67]	0.026
Duration of AH, years	7.5 [6; 11]	7.5 [5; 11]	0.832	7 [3.5; 11.5]	8 [4; 12]	0.320
SBP, office, mm Hg	165.3 [160; 170]	158.9 [155; 165]	0.165	158.3 [145; 167.5]	153.2 [145; 160]	0.801
DBP, office, mm Hg	100.3 [95; 105]	96.3 [90; 100]	0.117	97.7 [95; 100]	95.5 [90; 100]	0.802
HR, bpm	77.5 [74; 80]	74.7 [72; 80]	0.103	74.7 [70; 80]	74.9 [70; 78]	0.101
BMI, kg/m^2	29.7 [28.1; 31.5]	31.2 [28.9; 33.3]	0.034	29.8 [28.1; 31.7]	30.1 [26.0; 34.3]	0.891

The data is presented as the median and interquartile interval (Me [25th percentile; 75th percentile].
p_1 is for differences in the groups of male and female AH patients with depression; p_2 for differences in the groups of male and female AH patients without depression; AH, arterial hypertension; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate; BMI, body mass index.

Table 2. 24-hour BP monitoring in male and female patients with AH with and without depression

Parameter	AH patients with depression		p_1	AH patients without depression		p_2
	Male (n=50)	Female (n=48)		Male (n=32)	Female (n=31)	
SBP_{24}, mm Hg	157.9 [154.8; 162.6]	154.8 [149.6; 159.8]	0.0088	141.5 [132.0; 157.5]*	142.9 [134.0; 147.0]*	0.532
DBP_{24}, mm Hg	98.45 [94.3; 101.9]	94.95 [90.9; 99.7]	0.004	87.0 [80.0; 92.5]*	82.5 [76.0; 88.0]*	0.048
SBPd, mm Hg	157.25 [153.8; 164.2]	157.4 [152.3; 161.7]	0.490	146.5 [138.0; 166.0]*	142.0 [137.0; 151.0]*	0.261
DBPd, mm Hg	98.6 [94.9; 103.6]	98.2 [93.1; 101.6]	0.141	88.0 [81.0; 98.0]*	84.0 [76.0; 92.0]*	0.043
SBPd load, %	91.8 [86.7; 94.2]	86.7 [82.8; 89.2]	0.00004	72.5 [41.0; 89.0]*	55.0 [38.0; 79.0]*	0.170
DBPd load, %	85.3 [82.7; 87.7]	81.2 [76.7; 82.9]	0.00001	51.0 [13.0; 71.0]*	31.0 [13.0; 52.0]*	0.045
SBPd var, mm Hg	18.6 [17.8; 19.1]	17.1 [16.1; 18.9]	0.00024	15.5 [12.0; 17.0]*	18.0 [14.0; 22.0]	0.031
DBPd var, mm Hg	17.3 [16.3; 17.9]	16.3 [15.1; 17.7]	0.0043	9.0 [8.0; 12.0]*	12.0 [9.0; 15.0]*	0.090
SBPn, mm Hg	148.1 [141.7; 152.3]	145.1 [139.3; 149.1]	0.037	139.5 [127.0; 149.0]*	135.0 [127.0; 150.0]*	0.382
DBPn, mm Hg	95.0 [90.4; 97.8]	92.7 [89.2; 95.0]	0.047	81.5 [72.0; 88.0]*	74.0 [69.0; 84.0]*	0.021
SADn load, %	85.6 [82.5; 88.5]	77.9 [75.6; 81.9]	0.00001	94.0 [59.0; 100.0]	82.0 [54.0; 100.0]	0.192
DBPn load, %	83.5 [76.5; 85.3]	74.5 [72.1; 79.1]	0.00001	85.5 [40.0; 93.0]	50.0 [28.0; 89.0]	0.131
SBPn var, mm Hg	17.8 [16.8; 18.6]	16.6 [15.7; 18.0]	0.007	12.0 [9.0; 14.0]*	14.0 [9.0; 18.0]*	0.201
DBPn var, mm Hg	16.9 [15.9; 17.6]	15.7 [14.7; 16.5]	0.00006	9.5 [7.0; 12.0]*	10.0 [7.0; 12.0]*	0.631
SBP MS, mm Hg	53.7 [47.1; 58.7]	48.0 [40.9; 56.5]	0.019	39.5 [30.0; 50.0]*	36.0 [31.0; 59.0]*	0.763
DBP MS, mm Hg	37.6 [35.6; 38.9]	32.6 [30.2; 35.3]	0.00001	31.0 [23.0; 35.0]*	30.0 [21.0; 35.0]*	0.911
SBP MSR, mm Hg/h	13.4 [12.8; 14.2]	12.8 [12.3; 13.6]	0.0085	14.0 [11.0; 15.5]	16.0 [11.0; 21.0]	0.601
DBP MSR, mm Hg/h	13.2 [12.6; 13.7]	12.2 [11.5; 12.6]	0.000001	11.5 [7.0; 15.0]*	14.0 [8.0; 22.0]	0.541
HR_{24}, bpm	73.0 [69.0; 78.0]	72.0 [67.5; 78.0]	0.491	66.5 [59.5; 74.0]*	69.0 [61.0; 76.0]	0.191

p_1, significance of the differences of indicators in the groups of male and female AH patients with depression;
p_2, significance of the differences of indicators the groups of male and female AH patients without depression;
*, $p<0.05$ for groups of patients with AH with and without depression; AH, arterial hypertension; BP, blood pressure; SBP, systolic blood pressure; SBP_{24}, mean 24-hour systolic blood pressure; SBPn, mean night-time systolic blood pressure; SBPd, mean daytime systolic blood pressure; DBP, diastolic blood pressure; DBP_{24}, mean 24-hour diastolic blood pressure; DBPn, mean night-time diastolic blood pressure; DBPd, mean daytime diastolic blood pressure; Var, variability; MS, morning surge; MSR, morning surge rate; HR_{24}, mean 24-hour heart rate.

Table 3. Types of 24-hour BP curves in male and female patients with AH with and without depression

Type of 24-hour BP curve	AH patients with depression			
	Male (n=50)		Female (n=48)	
	SBP	DBP	SBP	DBP
Dipper	15 (30)	0	18 (37.5)	1 (2.1)
Non-dipper	31 (62)	43 (86)	27 (56.3)	39 (81.3)
Night-peaker	4 (8)	7 (14)	3 (6.2)	8 (16.6)
Over-dipper	0	0	0	0
	AH patients without depression			
	Male (n=32)		Female (n=31)	
	SBP	DBP	SBP	DBP
Dipper	8 (25)	8 (25)	11 (35.5)	15 (48.4)*
Non-dipper	13 (40.6)	17 (53.1)*	13 (41.9)	11 (35.5)*
Night-peaker	8 (25)*	4 (12.5)	7 (22.6)*	3 (9.7)
Over-dipper	3 (9.4)	3 (9.4)	0	2 (6.4)

The data is expressed as the absolute and relative rates, n (%) *, $p<0.05$ for groups of AH patients with and without depression.
AH, arterial hypertension; BP, blood pressure; SBP, systolic blood pressure; DBP, diastolic blood pressure.

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Table 4. VWS and CAP in patients with AH

Parameter	AH patients with depression		p_1	AH patients without depressionи		p_2
	Male (n=50)	Female (n=48)		Male (n=50)	Female (n=48)	
RWTT, ms	121,0 [113,0; 128,0]*	125,0 [119,5; 130,0]	0,041	127,5 [119,0; 134,5]	124,0 [116,0; 129,0]	0,191
$RWTT_{N1}$, ms	131,5 [123,0; 140,0]*	137,5 [127,0; 145,0]	0,037	138,5 [129,5; 144,0]	136,0 [128,0; 147,0]	0,783
PWVao, m/s	11,1 [10,6; 12,4]*	10,8 [10,2; 11,7]	0,029	10,8 [9,8; 11,8]	10,8 [9,9; 11,8]	0,451
$PWVao_{N1}$, m/s	10,0 [10,0; 11,1] *	9,8 [9,0; 10,0]	0,011	9,4 [9,0; 10,0]	10,0 [8,0; 10,0]	0,301
ASI, mm Hg	184,0 [158,0; 211,0]	187,0 [162,0; 214,0]	0,721	171,0 [136,0; 187,0]	182,0 [154,0; 202,0]	0,140
ASI_N, mm Hg	135,5 [116,0; 186,0]*	173,0 [143,5; 202,0] *	0,007	114,0 [89,5; 142,0]	157,0 [105,0; 176,0]	0,019
AIx, %	–7,0 [–23,0; 8,0]*	4,0 [– 9,5; 14,5]	0,052	–25,5 [–37,0; –1,5]	4,0 [–12,0; 13,0]	0,00088
AIx_{N1}, %	–20,0 [–33,0; –2,0]*	–1,5 [– 15,5; 13,5]	0,00017	–32,0 [–46,0; –16,5]	–7,0 [–21,0; 6,0]	0,00046
AASI	0,646 [0,504; 0,786]*	0,493 [0,332; 0,627]	0,00026	0,539 [0,360; 0,611]	0,540 [0,445; 0,683]	0,291
SBPao, mm Hg	136,5 [130,0; 144,0]	132,0 [127,5; 139,0]	0,0286	134,0 [126,5; 139,5]	131,0 [124,0; 139,0]	0,471
DBPao, mm Hg	87,5 [82,0; 91,0]*	82,5 [78,0; 89,5]	0,010	83,0 [75,5; 90,5]	86,0 [78,0; 91,0]	0,432
mBPao, mm Hg	109,5 [104,0; 113,0]*	106,0 [102,0; 113,5]	0,291	102,5 [96,0; 114,0]	110,0 [102,0; 114,0]	0,141
PPao, mm Hg	50,5 [45,0; 54,0]	50,0 [42,5; 57,0]	0,981	50,0 [44,0; 55,0]	46,0 [37,0; 55,0]	0,132
Aix ao, %	31,0 [18,0; 38,0]*	33,5 [26,5; 38,5]	0,191	23,5 [15,0; 29,5]	33,0 [26,0; 42,0]	0,00006
$Aix\ ao_{N1}$, %	25,0 [9,0; 34,0]	33,0 [23,5; 40,0]	0,0045	16,0 [7,5; 26,0]	36,0 [23,0; 41,0]	0,0002
PPA, %	128,0 [122,0; 138,0]	125,0 [121,0; 128,5]	0,019	127,0 [120,5; 133,5]	126,0 [122,0; 131,0]	0,731
PPA_{N2}, %	133,5 [131,0; 138,0]	130,0 [128,0; 133,0]	0,00009	132,5 [130,0; 136,5]	130,0 [127,0; 134,0]	0,061
ED, ms	331,0 [300,0; 361,0]	352,0 [322,5; 378,0]	0,0065	338,0 [321,0; 372,0]	346,0 [329,0; 384,0]	0,501
ED_N, ms	302,5 [288,0; 327,0]	321,0 [295,5; 342,0]	0,019	308,5 [294,5; 329,0]	326,0 [312,0; 349,0]	0,0093
SERV, %	126,0 [112,0; 133,0]	123,0 [110,5; 133,5]	0,491	130,0 [120,5; 146,0]	126,0 [116,0; 142,0]	0,281
$SERV_{N2}$, %	130,0 [122,0; 140,0]*	132,0 [121,0; 145,0]	0,251	143,0 [115,0; 157,5]	138,0 [122,0; 160,0]	0,341

p_1 is for the differences in the groups of male and female AH patients with depression; p_2 is for differences in the groups of male and female AH patients without depression; * $p<0.05$ is for groups of patients with AH with and without depression; AH, arterial hypertension; CAP, central aortic pressure; VWS, vascular wall stiffness; N1 – values normalized to SBP 100 mm Hg and HR 60 bpm; N2 – values normalized to HR 75 bpm; RWTT, reflected wave transit time; PWVao, pulse wave velocity in the aorta; ASI, arterial stiffness index; AIx, augmentation index; AASI, ambulatory arterial stiffness index; SBPao, mean 24-hour systolic blood pressure in the aorta; DBPao, mean 24-hour diastolic blood pressure in the aorta; PPao, mean 24-hour pulse pressure in the aorta; AIx ao, aortic augmentation index; PPA, pulse pressure amplification; ED, left ventricular rejection duration; SEVR, subendocardial viability ratio.

Discussion

Much attention is being paid now by researchers to the gender-associated aspects of CVD diagnosis and treatment. It is believed that understanding the differences in pathogenesis, risk factors, the progression of AH, CHD, CHF in male and female patients can contribute to the improvement of drug treatment and result in better prognosis at the population level [4].

The results of our study demonstrated more pronounced changes in 24-hour BP monitoring in AH patients with depression compared to those without depression. Moreover, male AH patients with depression had significantly higher values of the 24-hour BP monitoring indicators compared to female patients. The data in the literature on gender-associated features of the course of AH in patients with psycho-emotional disorders are contradictory. This can be due to differences in the studied populations of patients, the severity of AH, depression, etc. Nevertheless, the large Kangbuk Samsung Health Study of 175,970 patients with prehypertension, AH, and depression showed with some credibility that increased blood pressure and depression were more closely correlated in male patients compared to female patients [17]. At the same time, based on additional analysis, the authors concluded that the correlation became less strong at 55 years of age. In our study, the mean age of both male and female patients exceeded this age criterion. However, BP values, especially mean 24-hour and night-time BP, were statistically significantly higher in male patients with depression than in female patients.

Higher levels of BP in patients with depression compared to those without psycho-emotional disorders can be explained by several mechanisms. The underlying basis of depression is the deficiency of the serotonergic and noradrenergic systems [18]. There is significant data showing the important role of increased activity of the hypothalamic-pituitary-

adrenal axis and hypercortisolemia in the development of depression [19]. At the same time, the increased levels of glucocorticoids and hyperactivation of the renin-angiotensin-aldosterone system (RAAS) are closely correlated, including in the brain structures responsible for emotional disorders [20]. Overactivation of the pressure systems is likely to contribute to a significant increase in the BP levels in patients with depression.

The adequate functioning of RAAS depends largely on the levels and types of sex hormones, estrogen and testosterone, which to a certain extent is determining in male and female patients. For example, the activity of ACE, angiotensin II and the density of angiotensin II receptors of type 1 is high in male patients with adequate testosterone levels. RAAS elements which provide mostly positive cardiovascular effects prevail, by contrast, in female patients, at least before the onset of menopause: ACE 2, angiotensin 1–7, MAS receptors, and angiotensin II receptors of type 2 [21, 22]. Levels of angiotensin II and density of receptors of type 1 increase during menopause. Moreover, BP increases more significantly in male patients than female patients, even with comparable high levels of angiotensin II [23, 24]. The gender-associated particularities of mean 24-hour monitoring measurement in AH patients with depression and those without depression, shown in our study, can be expected to be due to the mentioned changes in RAAS activity.

It is a little more difficult to explain the gender-associated differences in the parameters of AWS and CAP. In our study, male AH patients with depression experienced statistically more significant changes in pulse wave travel time and velocity, ambulatory arterial stiffness index, aortic SBP and DBP, when compared to female patients. The values of the pulse pressure augmentation and amplification indices were, in turn, significantly higher in female patients than in male patients. European and Russian experts believe that pulse wave measurements and CAP are among the key indicators of atherosclerosis progression, development of clinically significant CVDs, and deterioration of the prognosis, while augmentation index remains an important but insufficiently sensitive parameter [8, 24, 25]. Thus, according to our findings, arterial wall remodeling may be more pronounced in male AH patients with depression than in female patients. A similar trend, although less significant, was observed for AWS and CAP in male and female patients without depression. However, depression concomitant to AH in male patients showed a significant deterioration in these parameters compared to male patients without psycho-emotional disorders. Overactivation of the sympathoadrenal system and RAAS in depression contributes to more pronounced remodeling of arterial walls, especially in male patients.

Conclusion

We have determined the gender-associated particularities of the 24-hour blood pressure profile, arterial wall stiffness, and central aortic pressure in patients with arterial hypertension and depression. Concomitant depressive disorders in patients with arterial hypertension is accompanied by pronounced pathological changes of the 24-hour blood pressure monitoring parameters, as well as central aortic pressure and arterial wall stiffness. The severity of adverse changes in these indicators is more significant in male patients with depression than female patients. These findings should be considered in the screening of arterial hypertension and psycho-emotional disorders and may be considered when selecting combination antihypertensive and psychotropic drug treatment. This should improve the 24-hour blood pressure profile and provide vasoprotection.

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