Arterial stiffness in women with arterial hypertension with regard to menopause

Yushchuk Elena Nikolaevna
Doctor of Medical Sciences, Full Professor
A.I. Yevdokimov Moscow State University of Medicine and Dentistry
Medvedeva Elizaveta Georgievna
Assistant
A.I. Yevdokimov Moscow State University of Medicine and Dentistry
Sapunova Daria Alexandrovna
Candidate of Medical Sciences, Assistant
A.I. Yevdokimov Moscow State University of Medicine and Dentistry

Abstract: An individual approach to the prevention and treatment of arterial hypertension in women should be the basis of personalized medicine, taking into account the gynecological history. On the clinical basis of the university, 92 women with previously diagnosed arterial hypertension were examined. The comparison was carried out according to anthropometric data, indicators of biochemical blood tests and an indicator of pulse wave velocity, which characterizes arterial stiffness. An increase in the speed of the pulse wave with an increase in the blood pressure numbers was revealed. The study additionally confirmed the effect of early, adequately selected menopausal hormone therapy on the course of arterial hypertension.
Keywords: arterial hypertension, arterial stiffness, menopause

The leading pathology contributing to the risk of cardiovascular complications and mortality in older patients is arterial hypertension (AH) [1]. Of great practical importance is the relationship between age and AH observed during the aging process [2]. This is accompanied by a number of changes in the vascular system, in particular, endothelial dysfunction, increased vascular stiffness, vascular wall remodeling and inflammation, which determine the so-called "vascular phenotype" of AH [3].

Arterial stiffness, which is a marker of vascular damage and an independent predictor of cardiovascular disease, can be used as an indicator of vascular aging.

The pulse wave velocity in the carotid-femoral area is currently considered the most informative indicator of arterial stiffness, reflecting the combined effect of known and unknown risk factors for damage to the arterial wall [4]. Previous studies on gender differences indicate that women are characterized by a higher arterial stiffness with a subsequent increase in the load on the left ventricle of the heart and an increased risk of developing heart failure with a preserved ejection fraction [5,6].

On a clinical basis of A.I. Yevdokimov Moscow State University of Medicine and Dentistry, a single study included 92 patients in menopause, both natural and surgical, with a previously established diagnosis of AH. Clinical examination of patients included clarification of complaints, detailed collection of gynecological anamnesis for women, specifying the presence (and duration) or absence of menopausal hormone therapy; arterial hypertension and identification of risk factors for arterial hypertension and coronary heart disease; clinical examination, which included measurement of blood pressure (BP), heart rate (HR), height, weight, calculation of the body mass index (BMI) by the Quetelet index [body weight (kg)/height (m^2)]. The patients underwent a biochemical blood test: total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C), triglycerides (TG), glucose were determined. To assess vascular stiffness, the pulse wave velocity was measured in the area from the carotid to the femoral artery. Pulse wave velosity (PWV) was measured using a Pulse Trace PWV device (Micro Medical, United Kingdom), which measures arterial stiffness between two points of the arterial system.

Descriptive statistics, including the number of observations in each group, mean (M), standard deviation (SD), and percentages were given for all indicators, depending on the nature of the data. Comparison of dependent groups for quantitative variables with parametric distribution of data was carried out using the Student's t-test, with nonparametric distribution - using the Smirnov-Kolmogorov test. All statistical tests were performed for a two-tailed level of statistical significance $(p)<0.05$.

The patients were divided into three subgroups depending on the severity of the course of arterial hypertension.

Table 1

Characteristics of patients with AH, depending on its degree

Indicator	Patients with grade I AH	Patients with grade 2 AH	Patients with grade 3 AH
Number of patients	57	24	11
Age (years)	52.05±6.59*	57.00±5.49	57.73±6.56
Height (cm)	163.76±5.41	162.75±5.29	150.63±30.74
Weight, kg)	74.73±15.31*	81.79±13.48	89.55±29.61
BMI (kg/m²)	27.89±5.57*	30.86±4.87	31.70±8.76
SBP (mmHg)	133.60±3.87*	151.04±6.42**	175.45±12.93***
DBP (mmHg)	85.96±6.78*	96.04±6.75**	107.27±11.04***
HR (beats/min)	74.77±11.38*	68.33±9.06**	77.82±13.68

PWV (m/s)	11.15±2.09*	13.58±3.71	15.24±3.27***
TC (mmol/l)	5.72±1.19	5.57±1.38	5.74±0.93
TG (mmol/l)	1.35±0.75	1.40±0.62	1.47±0.77
LDL-C (mmol/l)	3.72±0.51	3.09±0.38	3.53±0.69
HDL-C (mmol/l)	1.50±0.43	1.37±0.27	1.23±0.34***
Glucose (mmol/l)	5.22±0.66	5.14±0.92	5.23±0.60
Duration of AH disease (years)	4.60±4.42*	10.38±9.45	12.7±9.63

* - $p<0.05$ between 1st and 2nd groups of patients

** - $p<0.05$ between the 2nd and 3rd groups of patients

*** - $p<0.05$ between 1st and 3rd groups of patients

Analyzing the results obtained, presented in table 1, it should be noted the presence of unidirectional changes in BP values (SBP, DBP) and dynamics of the pulse wave velocity depending on the degree of AH. Thus, in patients of the 1st group, the mean values of arterial stiffness were less than in the other groups, but reached values of 10 m/s, which determine the risk of cardiovascular complications [7]. As the course of AH worsened (progression of the degree of the disease), an increase in the pulse wave velocity was noted, the magnitude of which significantly differed from those in patients of the 1st group. The average absolute values of PWV in the 2nd and 3rd groups significantly exceeded the "safety threshold" for the development of cardiovascular complications. Thus, there is an undeniable relationship between the progression of AH and the increase in arterial stiffness in women with essential hypertension. This conclusion is undoubtedly of great importance for the implementation of preventive and therapeutic measures. Analyzing the metabolic parameters of patients with AH, it should be noted that in all three groups the examined women had increased BMI values corresponding to various degrees of obesity, as well as lipid metabolism disorders corresponding to atherogenic dyslipidemia (increased concentration of LDL-C and decreased HDL-C). These disorders of lipid metabolism did not have regular differences depending on the severity of AH, with the exception of HDL-C, a significant and significant decrease in which was found in patients of the 3rd group. Thus, metabolic disorders of varying severity are present at all, including at the early stages of the development of the disease, thereby participating in the development of AH complications and, above all, the formation of arterial stiffness.

In addition, the patients underwent an analysis of the peculiarities of their gynecological status. Of interest were the cause of menopause and the menopausal hormone therapy (MHT) carried out in some cases.

All women in the natural menopause subgroup did not receive menopausal hormone therapy. Most patients from the subgroup with surgical menopause had a history of taking menopausal hormone therapy, so it seemed interesting to compare these two subgroups with each other, taking into account the degree of arterial hypertension.

Table 2

Main indicators in patients with AH grade 1, depending on the cause of menopause

Indicator	Surgical menopause (N=41)	Natural menopause (N=16)
Age, years	51.98±6.68	52.25±6.55
Height (cm)	163.35±5.46	164.81±5.28
Weight (kg)	72.58±10.72	80.25±22.88
BMI (kg/m^2)	27.24±4.08	29.56±8.21
SBP (mmHg)	133.29±3.81	134.38±4.03
DBP (mmHg)	87.07±6.52	82.50±5.48*
HR, beats/min	73.85±11.75	77.13±10.31
PWV (m/s)	10.90±1.97	11.78±2.31
TC (mmol/l)	5.66±0.99	5.89±1.75
TG (mmol/l)	1.26±0.70	1.70±0.87
LDL-C (mmol/l)	3.83±0.52	3.31±0.25
HDL-C (mmol/l)	1.56±0.41	1.19±0.45
Glucose (mmol/l)	5.28±0.67	4.98±0.60
Duration of AH disease (years)	4.78±4.86	4.12±3.09

* - $p<0.05$ between the 1st and 2nd subgroups of patients

Analyzing the presented results, we did not find a significant difference in the vast majority of parameters. Despite the comparable age, at the time of the study, these subgroups differ significantly from each other. The difference is due to the fact that the first subgroup (surgical menopause) consists of patients in whom menopause occurred on average 10 years earlier due to surgery than the representatives of the second subgroup with natural menopause. On average, patients of the second subgroup are in a state of natural menopause for about 3 years. Patients in the surgical menopause subgroup received an adequately matched menopausal hormone therapy program, which appears to have contributed to the lack of differences between this subgroup and the subgroup of patients with natural menopause.

In the group of patients with grade 2 AH, there was no prescription for menopausal hormone therapy in women with natural menopause, therefore subgroups of women with surgical (n = 15) and natural menopause (n = 9) were compared in a similar way (table 3).

Table 3

Main indicators in patients with AH grade 2, depending on the cause of menopause

Indicator	Surgical menopause (N=15)	Natural menopause (N=9)
Age, years	56.80±4.89	57.33±6.67
Height (cm)	163.00±4.68	162.33±6.46
Weight (kg)	85.77±12.64	75.17±12.81
BMI (kg/m²)	32.26±4.47	28.53±4.85
SBP (mmHg)	152.33±6.51	148.89±6.01
DBP (mmHg)	95.67±6.78	96.67±7.07
HR, beats/min	67.67±6.91	69.44±12.25
PWV (m/s)	13.67±4.37	13.45±2.45
TC (mmol/l)	5.57±1.53	5.56±1.17
TG (mmol/l)	1.42±0.71	1.38±0.48
LDL-C (mmol/l)	3.09±0.38	3.31±0.25
HDL-C (mmol/l)	1.37±0.22	1.37±0.49
Glucose(mmol/l)	5.39±1.02	4.66±0.43
Duration of AH disease (years)	11.87±10.91	7.89±6.09

As can be seen from table 3, the reliability of differences was not revealed between patients with surgical and natural menopause, suffering from arterial hypertension of the 2nd degree, which is even more consistent with the previous conclusions in patients of the 1st group, since the indicators and especially arterial stiffness do not significantly differ in subgroup of surgical menopause, despite a significantly longer history of AH.

In the third group of women with grade 3 AH (n=11), the distribution of women by type of menopause is presented as follows: 8 patients with surgical menopause; three women have natural menopause. It does not seem appropriate to make comparisons in this subgroup due to the small number of samples.

When conducting a correlation analysis on the relationship between the PWV indicator and clinical and anamnestic indicators, several significant ($p<0.05$) correlations were obtained for groups of

women with AH. Of considerable interest is the presence of a significant negative relationship between the value of the pulse wave velocity and the duration of menopausal hormone therapy, which additionally illustrates the previously found relationship between a better vascular condition in patients with AH of varying degrees. The increase in the strength of this bond is clearly demonstrated in table 4.

Table 4

Correlation relationship between the index of stiffness of the arteries with clinical and anamnestic indicators by groups of patients

Correlations of PWV with different indicators	Patients with grade I AH	Patients with grade II AH	Patients with grade III AH
HR	-0.28	n.a.	n.a.
Duration of taking MHT	-0.27	-0.48	-0.71
Duration of AH disease	n.a.	0.41	n.a.

Analyzing the metabolic parameters of patients with AH, it should be noted that in all three groups the examined women had increased BMI values corresponding to various degrees of obesity, as well as lipid metabolism disorders corresponding to atherogenic dyslipidemia (increased concentration of LDL-C and decreased HDL-C). The indicated lipid metabolism disorders did not have regular differences depending on the severity of AH, with the exception of HDL-C, a significant and significant decrease in which was found in patients with grade 3 AH. Thus, metabolic disorders of varying severity are present at all, including at the early stages of the development of the disease, thereby participating in the development of complications of arterial hypertension and, above all, the formation of arterial stiffness.

In patients with AH, we did not obtain significant differences in most of the studied parameters depending on the cause of menopause (surgical or natural). This fact can be interpreted from the standpoint of the effectiveness of previously conducted menopausal hormone therapy, which neutralized the more severe effect of a sharp shutdown of the ovaries on the formation of pathology of cardiovascular diseases during surgical menopause. Of considerable interest is the presence of a significant negative relationship between the value of the vascular stiffness indicator and the duration of menopausal hormone therapy. Thus, this study additionally confirmed the effect of early, adequately selected menopausal hormonal therapy on the course of arterial hypertension.

1. Tkacheva O.N., Runixina N.K., Kotovskaya Yu.V. et al. Arteraial hypertension management in patients aged older than 80 years and patients with the senile asthenia. A position agreement of the experts of Russian association of gerontologists and geriatricians, Gerontological society of Russian Academy of Sciences, Russian medical society for arterial hypertension. Cardiovascular Therapy and Prevention. 2017; 16(1): 8-21. doi: 10.15829/1728-8800-2017-1-8-21 [in Russian].
2. Wang M., Monticone R.E., Lakatta E.G. Arterial aging: a journey into subclinical arterial disease. Curr Opin Nephrol Hypertens. 2010; 19(2): 201-207. doi: 10.1097/MNH.0b013e3283361c0b.
3. Barja G. Updating the mitochondrial free radical theory of aging: an integrated view, key aspects, and confounding concepts. Antioxid Redox Signal. 2013; 19(12): 1420-1445. doi: 10.1089/ars.2012.5148.
4. Laurent S, Marais L, Boutouyrie P. The Noninvasive assessment of vascular aging. Can J Cardiol. 2016;32(5):669–679. doi:10.1016/j.cjca.2016.01.039
5. Coutinho T, Borlaug B, Pellikka P, Turner S, Kullo I. Sex differences in arterial stiffness and ventricular-arterial interactions. J Am Coll Cardiol. 2013;61(1):96–103. doi:10.1016/j.jacc.2012.08.997
6. Sapunova D. Arterial hypertension - a view from the perspective of gender differences. International Conference “Scientific research of the SCO countries: synergy and integration”. Beijing. 4 AUGUST 2021. Melbourne, 2021. P. 119-125. DOI:10.34660/INF.2021.39.54.016
7. Cardiovascular prevention 2017. National Guidelines. Russian Journal of Cardiology. 2018;(6):7-122 (In Russ.) DOI:10.15829/1560-4071-2018-6-7-122.