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Darii I.V.
Ph.D. student
State Institution
"Institute of Neurology, Psychiatry and Narcology of the
National Academy of Medical Sciences of Ukraine",
Kharkiv, Ukraine

FEATURES OF CHANGES IN THE STRUCTURE OF THE VASCULAR WALL IN PATIENTS WITH CHRONIC CEREBRAL ISCHEMIA DEPENDING ON THE PRESENCE OF METABOLIC SYNDROME

Annotation. Relevance. Cerebrovascular diseases are one of the leading mortality and disability populations in the world. Metabolic syndrome significantly increases the risk of stroke, mortality, the severity of neurological and cognitive deficits in chronic cerebral ischemia, etc.

The aim of the study: to determine the features of changes in the structure of the vascular wall in patients with chronic cerebral ischemia, depending on the presence of metabolic syndrome.

Materials and methods: in a prospective study 69 patients with chronic cerebral ischemia were examined. The patients were randomized into 2 groups: the main group consisted of 40 patients with chronic cerebral ischemia and metabolic syndrome. In the comparison group there were 29 patients with signs of chronic cerebral ischemia without metabolic syndrome. The severity of atherosclerotic lesions of the arteries was investigated taking into account the structural changes of the vascular wall, the presence of intraluminal formations, as well as their ultrasonic characteristics. The thickness of the intima-media of the common carotid artery and its differentiation into layers were examined by ultrasound in B-mode.

Research findings and conclusions: for patients with chronic cerebral ischemia without metabolic syndrome, differentiation preservation into layers of the intima-media complex was observed more frequently than in patients with metabolic syndrome (more than 8-fold) ($p<0.05$). Moreover, after the age of 50, all patients with chronic cerebral ischemia and metabolic syndrome were impaired differentiation into layers of the intima-media complex, that is, this indicator was pathognomonic for this age and pathology. For patients with chronic cerebral ischemia and metabolic syndrome, the thickness of the intima-media complex of the common carotid artery was greater than compared with patients without metabolic syndrome ($p<0.05$). Patients with chronic cerebral ischemia and metabolic syndrome were found to have more than twice the benefit of having atherosclerotic plaques when compared with patients without metabolic syndrome ($p<0.05$).

Keywords: chronic cerebral ischemia, cerebrovascular diseases, metabolic syndrome, ultrasound, intima-media complex, atherosclerotic plaques.

Relevance (problem statement and analysis of recent research and publications).

Cerebrovascular diseases (CVD) are one of the leading position of mortality and disability of population in the world [1, 2]. Often, cerebrovascular diseases are based on carotid atherosclerosis, which is associated with the development of acute cardiovascular events, cognitive impairment, dementia, and other diseases [3]. Chronic cerebral ischemia (CCI) is the largest contributor to CVD, and metabolic syndrome (MS) is one of the complicating factors in the course of vascular diseases [2, 4, 5].

An important role in the diagnosis of CCI is ultrasound dopplerography (USDG), in which informative indicators of the morphological structure of the vessels is the thickness of the intima-media complex (IMC), the degree of its differentiation into layers, the presence of atherosclerotic plaques and their characteristics [3].

The presence of metabolic syndrome is associated with an increased risk of progression of the atherosclerotic process of the carotid artery, which indicates the important role of MS in the initiation of atherosclerosis [6, 7]. The relationship between MS, atherosclerosis and thickness of IMC is complex and reflects the relationship between these processes [7]. One of the predictors of diseases of small and large vessels may be MS, because its presence is significantly correlated with atherosclerosis throughout the body, including small cerebral vessels, extra-carotid arteries, coronary arteries and abdominal aorta [8].

Highlighting previously unresolved parts of a common problem.

The literature research has found little data on the features of impaired differentiation into layers of the intima-media complex, the thickness of the intima-media complex depending on the localization in the common carotid artery, and the quantitative difference in the presence of atherosclerotic plaques in patients with chronic cerebral ischemia depending on the presence of cerebral ischemia.

The aim of the study.

Determination of features of changes in the structure of the vascular wall in patients with chronic cerebral ischemia, depending on the presence of metabolic syndrome.

Presenting main material.

Research materials and methods.

The study included 69 patients with CCI. Chronic cerebral ischemia was diagnosed according to generally

accepted criteria: the presence of neurological, cognitive, emotionally-affective signs of brain damage, brain structural changes according to neuroimaging, and others [9]. Neuroimaging methods (MRI, CT) were used to clarify the diagnosis. The patients were randomized into 2 groups: the main group (MG) was 40 patients with chronic cerebral ischemia and metabolic syndrome. In the comparison group (CG) there were 29 patients with signs of chronic cerebral ischemia without metabolic syndrome. The average age of the surveyed persons was 59.17±1.04 years.

According to the updated criteria, the recommendations of the Association of Cardiologists of Ukraine and the Association of Endocrinologists of Ukraine in the presence of three or more factors revealed MS: hypertension (BP > 130/85 mm Hg) or the use of antihypertensive drugs, obesity (waist circumference > 94 cm for men, > 80 cm for women) and dyslipidemia (increase in serum triglycerides ≥ 1.7 mmol/l or normal triglyceride levels with appropriate therapy; decrease in high density lipoprotein (HDL) < 1 mmol/l for men and < 1,3 mmol/l for women or normal level of HDL with appropriate therapy), increased fasting blood plasma glucose ≥ 5,6 mmol/l or treatment of hyperglycemia [10].

The severity of atherosclerotic lesions of the brachiocephalic arteries was investigated taking into account the structural changes of the vascular wall, the presence of intraluminal formations, as well as their ultrasonic characteristics. The thickness of the intima-media complex of the common carotid artery and its differentiation into layers was examined by ultrasound in B-mode. IMC thickness of less than 0.9 mm was considered normal according to the recommendations of the American Heart Society (AHA). Determined the value of stenoses in percentage relative to the diameter of the vessel. The modified classification of Gray-Weale and co-authors evaluated the echogenicity of atherosclerotic plaques.

Quantitative data is presented in the form of median and interquartile interval, qualitative data - in the form of number and percent. The Shapiro-Wilk test was used to estimate the normality of distribution. Levine test was used to evaluate the variance homogeneity. Pairwise comparisons were made using Mann-Whitney U test, qualitative data comparisons - using Pearson Chi-square test. Two-sided value of $p<0.05$ was considered statistically significant.

Results of the study and their discussion.

The main indicators in the ultrasound examination of the structure of the vessels of the head and neck for us were changes in the echostructure of the complex of intima-media of large arterial trunks: diffuse, uneven change of echogenicity, the degree of differentiation into layers and surface shapes in combination with pathological thickening of the standard evaluation (common carotid artery (CCA)) with the reduction of the lumen of the vessel in the diameter of not more than 20%, IMC thickness of 0.9 mm was the boundary for the common carotid arteries. The above signs are important in the diagnosis of CCI and the establishment of the degree of atherosclerotic changes in blood vessels [3]. Studies have shown that IMC is a marker of atherosclerotic vascular injury and reflects the various stages of atherosclerosis [11].

An important indicator of changes in the morphological structure of the vascular wall was the violation of differentiation into layers of IMC and the degree of its severity. The impaired differentiation of IMC into layers in patients with CCI and MS was as follows: in 19 (47.5%) patients - partially lost, and in 20 (50%) patients were lost. In patients with CCI without MS, violation of differentiation of IMC layers was observed in 23 patients (79.3%), in terms of severity it was: in 12 (41.4%) patients - differentiation was partially lost, in 11 (37.9%) - lost. The absence of changes in the vascular wall was observed in patients with CCI without MS in 6 (20.7%) cases, and in patients with MS only in 1 (2.5%), i.e more often almost 8 times ($p<0.05$). Moreover, after the age of 50, all patients with chronic cerebral ischemia and metabolic syndrome had impaired differentiation into layers of the intima-media complex.

An important study of the vascular wall structure was that in almost all patients with MS, there was a violation of IMC differentiation into layers of varying degrees - in 39 (97.5%) patients; for patients with no MS the violation of IMC differentiation into layers was observed in 23 (79,3%) cases only ($p<0.05$). In patients with CCI and MS after the age of 50 years, this indicator was pathognomonic and was observed in 100% of patients, while in the surveyed without MS, this indicator was found after 50 years only in 20 (83.3%) cases ($p<0.05$).

Atherosclerotic lesions of major head and neck arteries in patients with CCI, according to ultrasound can be conditionally divided into 2 stages: non-stenotic and stenotic. Non-stenotic changes are determined in the stage of lipoidosis and the initial stages of liposclerosis in accordance with the morphogenesis of atherosclerosis. The process goes into a stenotic stage at formation of a fibrinous atherosclerotic plaque, ulceration, atherocalcinosis [3]. The standard method of examination for the detection of atherosclerotic lesions of the carotid arteries is the study of the thickness of IMC [12], so it was important for us to evaluate this indicator (Table 1).

In the study of the thickness of the IMC of the common carotid artery by 15 mm more proximal from the bifurcation, the following changes were detected. The IMC thickness of the left CCA by 15 mm from the bifurcation in patients with CCI with MS and with no MS was 0.7 (0.6; 0.9) cm and 0,6 (0.6; 0.6) cm, respectively ($p<0.05$). The thickness of the IMC of the right CCA by 15 mm from the bifurcation in patients with CCI with MS and with no MS was 0.6 (0.6; 0.9) cm and 0.6 (0.6; 0.7) cm, respectively ($p>0.05$).

Therefore, for patients with CCI and MS, the IMC thickness of the CCA was greater by 15 mm more proximal from bifurcation than for patients with no MS: IMC thickness of the left CCA was significantly greater ($p<0.05$), IMC thickness of the right CCA had no significant difference ($p>0.05$).

Table 1

Thickness of the intima-media complex of the common carotid arteries by 15 mm more proximal from bifurcation in patients with chronic cerebral ischemia depending on the presence of metabolic syndrome

Group Indicator	Main group (n = 34)	Comparison group (n = 18)
IMC thickness of the left CCA by 15 mm from the bifurcation, cm	0.7 (0.6; 0.9)*	0.6 (0.6; 0.6)
IMC thickness of the right CCA by 15 mm from the bifurcation, cm	0.6 (0.6; 0.9)	0.6 (0.6; 0.7)
*p <0.05 when comparing the values of the main group and the comparison group.		

In the study of atherosclerotic plaques, we evaluated their stability and instability, structure (homogeneous hypoechoic, heterogeneous with predominance of hypoechoic component; heterogeneous with predominance of hyperechoic component; homogeneous hyperechogenic), length, echogenicity, hemorrhages inside the plaques, affected vessel damage degree, plaques prevalence local (less than 1.5 cm) or prolonged plaques (more than 1.5 cm), localization (segmental (covering up to 25% of the entire carotid artery (CA) circumference), semi-concentric (up to half the CA circle) and concentric (completely cover the circumference of the vessel)), the shape of the surface (smooth and rough).

In the patients of the main group and the comparison group, when assessing the presence of atherosclerotic plaques, the following was revealed: the absence of plaques was observed in 13 (32.5%) patients and 20 patients (69%), respectively (p<0.05), 1 plaque in 9 (22.5%) patients and 2 patients (6.9%), respectively, 2 plaques in 10 (25%) patients and 5 patients (17.2%), respectively, 3 and more plaques in 8 (20%) patients and 2 patients (6.9%), respectively (table 2).

Thus, atherosclerotic plaques were significantly more common in patients with CCI and MS than in patients without MS: 67.5% and 31%, respectively (more than twice) (p <0.05). An important indicator was the presence of three or more plaques in patients, since in patients with CCI and MS, it was noted almost 3 times more often than in patients without MS (20% and 6.9%, respectively).

Table 2

Presence and quantitative distribution of atherosclerotic plaques in patients with chronic cerebral ischemia depending on the presence of metabolic syndrome

Group Indicator	Main group (n = 40)		Comparison group (n = 29)	
	Number	%	Number	%
No plaques	13	32,5*	20	69*
1 plaque	9	22,5	2	6,9
2 plaques	10	25	5	17,2
3 and more plaques	8	20	2	6,9
*p<0,05 when comparing the values of the main group and the comparison group.				

Conclusions.

1. When analyzing the structure of the vascular wall in patients with chronic cerebral ischemia revealed a significant difference in the degree of impaired differentiation into layers of the intima-media complex. Thus, in patients with chronic cerebral ischemia and metabolic syndrome, differentiation preservation into the layers of the intima-media complex was observed in only 2.5% of cases, and in patients without metabolic syndrome - in 20.7% (p<0.05). Moreover, after 50 years old, all patients with chronic cerebral ischemia and metabolic syndrome had impaired differentiation into layers of the intima-media complex, that is, this indicator was pathognomonic for this age and pathology.

2. For patients with chronic cerebral ischemia and metabolic syndrome, the thickness of the intima-media complex of the left common carotid artery was significantly greater than for patients without metabolic syndrome: 0.7 (0.6; 0.9) cm and 0.6 (0.6; 0.6) cm, respectively (p<0,05).

3. For patients with chronic cerebral ischemia and metabolic syndrome, there is more than a twofold advantage of having plaques when compared with patients without metabolic syndrome: 67.5% and 31%, respectively (p<0.05).

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