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EVALUATION OF THE CHARACTER OF STRUCTURAL AND FUNCTIONAL CHANGES IN CEREBRAL VESSELS IN PATIENTS WITH ISCHEMIC CEREBROVASCULAR DISEASES ON THE BACKGROUND OF MULTIFOCAL LESIONS

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Key words: ischemic impairment of cerebral circulation, abnormal deformation of the internal carotid and vertebral artery, stenosing lesions of the internal carotid and vertebral artery

Ключові слова: ішемічні порушення мозкового кровообігу, патологічна деформація внутрішньої сонної артерії та хребтової артерії, стенозуюче ураження внутрішньої сонної артерії та хребтової артерії

Abstract. Evaluation of the character of structural and functional changes in cerebral vessels in patients with ischemic cerebrovascular diseases on the background of multifocal lesions. Rosits’ka O.A. The hemodynamic consequences of brain damage depend on the state of the autoregulation system of the cerebral circulation, on the severity, prevalence and rate of progression of the atherosclerotic process (one or more basins), changes in the vascular wall, and the features of the anatomical structure of the cerebral vascular system. Most registries cannot determine the cause of stroke in 25-40% of patients - the so-called cryptogenic strokes. Therefore, the question of underestimation of such disorders as tortuosity, extravasal compression, anomaly of development of not only internal carotid arteries, but also vertebral and subclavian arteries in the diagnosis of the effect on the course of cerebral ischemia is raised. In high-risk groups, the effect of pathology in the carotid arteries on the course of cerebral vascular disease is more often compared with the data of similar changes in extracranial vertebral arteries. In the general group of patients with multifocal lesion of the vessels (MFLV), tortuosity of blood vessels were found in the basins of the
internal carotid artery (ICA) and vertebral artery (VA) pools were less frequent than the carotid, but more pronounced. Atherosclerotic lesions of the subclavian artery (Left subclavian artery) are significantly more frequent in the group of patients with vascular lesions of the heart, brain and lower limbs. According to the data of the correlation analysis, possible associations of atherosclerotic vascular lesions of the main arteries of the head (MAH) are established, both among them and with other risk factors.

Atherosclerosis of the cerebral arteries is responsible for almost all causes of chronic cerebrovascular disorders, but it may also be clinically "dumb" [2]. Innovative studies of carotid limb showed its prevalence ranging from 5% to 25% in patients with cerebrovascular symptoms or with asymptomatic carotid stenosis, which was diagnosed accidentally [6].

Markers of atherosclerosis is a thickening of intima-media complex (IMC) and the presence of plaques in the common carotid artery (CCA). Thickening IMC mainly represents the adaptive hypertrophic response of smooth muscle cells in the middle membrane to significant hemodynamic shock. Plaques usually occur in areas of low hemodynamic shock and not laminar turbulent blood flow, such as on carotid artery and proximal internal carotid artery (ICA), at least in the distal CCA. Plaques and IMC could be a different phenotypes of atherosclerosis with different connections with cardiovascular risk factors and clinical vascular disease [7].

The expressiveness of the atherosclerotic lesion of the major arteries of the head does not always directly affect the incidence of ischemic cerebrovascular accidents (ICVA). The possibility of acute ICVA is largely determined by the state of the cerebral vascular reserve (CVR - the level of reactivity of the cerebrovascular vessels, which evaluates their ability to further increase blood circulation). Preservation of the CVR provides the functional stability of the whole system of cerebral circulation. In the CVR there are anatomical (connecting arteries of the circle of Willis, leptomeningeal and ophthalmic anastomoses, as well as directly the cerebral arteries) and functional (autoregulatory mechanisms of the brain blood circulation system) source of compensation. Deterioration of the CVR may be considered as a predictor of cerebral hemodynamic dysfunction [5].

The hemodynamic effects of atherosclerotic lesion of MAH depend on their severity and the prevalence of the process, the peculiarities of the anatomical structure of the vascular system of the brain, the rates of progression of the atherosclerotic process, as well as on the state of the system of autoregulation of the cerebral circulation [5].

Among the causes of chronic and acute cerebrovascular disorders, which determine the state of hemodynamics, is the pathological deformation of the BCA. The overall frequency of abnormal deformations of the ICA, according to data from dopplerographic, angiographic or pathoanatomical studies, varies within 10-40% of the adult population [1, 6] (without a history of atherosclerosis, diabetes or hypertension).

There is a lack of data on the impact of extracranial vertebral arteries on the course of vascular diseases of the brain, as compared to publications on similar changes in carotid arteries in high-risk groups. Most registries cannot determine the cause of a stroke in 25-40% of patients – the so-called
The study of the peculiarities of the distribution of atherosclerotic plaques in the basins of the brain, the discovery of some patterns of atherosclerotic lesion and pathological deformation of the arteries of the brain will contribute to more precise planning of diagnostic and therapeutic measures, improvement of the prognosis of the course of classical vascular diseases in patients with multifocal lesion of vessels (MFLV).

To study the character of the structural and functional characteristics of the vessels of the brain (extra-intracranial) according to Doppler ultrasonography and selective cerebral angiography (SCA) in patients with ischemic cerebrovascular diseases against the background of multifocal vascular lesion.

**MATERIALS AND METHODS**

The study included 125 patients aged 40 to 84 years with multifocal lesion of the vessels (MFLV). Depending on the localization of vascular basin defeat by stenotic atherosclerosis, all patients were divided into three clinical groups: I group – 19 (15.2%) patients with lesion of the vessels of the brain, heart, and lower limbs; group II – 87 (69.6%) patients with a lesion of vessels of the brain and heart; group III - 19 (15.2%) of patients with lesion of the vessels of the brain and lower limbs. Of these, 101 (80.8%) are males and 24 (19.2%) are female. The average age of patients was (62.9±0.79) years.

Evaluation of the neurological status was carried out with the identification of leading clinical symptoms and the establishment of a form of cerebral circulation disorder. The character of the vascular lesion was clarified with the help of Doppler ultrasonography of the main extra- and intracranial arteries on the device SONOS-1000 of Hewlett-Packard Company (USA), as well as selective cerebral angiography (SCA) in patients with ischemic cerebrovascular diseases.

The study of the peculiarities of the distribution of atherosclerotic plaques in the basins of the brain, the discovery of some patterns of atherosclerotic lesion and pathological deformation of the arteries of the brain will contribute to more precise planning of diagnostic and therapeutic measures, improvement of the prognosis of the course of classical vascular diseases in patients with multifocal lesion of vessels (MFLV).

**RESULTS AND DISCUSSION**

The analysis of the results of Doppler ultrasonography and SCA in patients with ICD showed a high incidence of stenosing defeat of the main vessels of the head (MAH), mostly in the carotid basin (Table 1). Almost all of the patients had lesions in the ICA basin (120 patients – 96.0%), including 87.2% in left internal carotid artery (L ICA) and 84.8% in right internal carotid artery (RICA). Bilateral lesions of the ICA were observed in 95 (76.0%) cases. At the same time, in the structure of the revealed disorders (215 cases in ICA), about half were hemodynamically significant stenoses (50-99%) or occlusions (110 cases - 51.2%).

The atherosclerotic lesion of vessels in the basins of BA and VA was less frequent compared with carotid, but more pronounced (table 1). Most often stenotic disorders were observed in VA - 46 (36.8%) patients, of which 28.0% of cases in LVA, 22.4% – in RVA, 13.6% – in both basins at the same time. In 46 of 71 (64.8%) cases of atherosclerotic lesions of VA and BA basins were hemodynamically significant stenoses (34-47.9%) and occlusion (12-16.9%).

The analysis of stenosing lesion of the MAH in patients with clinical groups (fig. 1) showed that:

- in all groups, the vessels of the ICA basin reach a stenosing process with roughly the same frequency (78.9-89.5%);
- LCCA is added to the stenosing process slightly more frequently in patients of group I – 31.6% vs. 19.5% in group II (p=0.249 for $\chi^2$) and 15.8% in group II (p=0.252 for $\chi^2$);
- atherosclerotic lesions of the subclavian artery (LSA) are more likely to occur in group I, than in II - 15.8% vs. 2.3% (p = 0.039 per FET);
- the percentage of stenotic vascular lesion of the vertebrobasilar basin (VBB) in patients with atherosclerosis of the coronary, cerebral basins and lower extremities (group I) is more than twice as high as in patients with II and III groups (except for RVA in group III): for LVA – 52.6% in group I compared with 24.1% in group II (p=0.013 for $\chi^2$) and 21.1% in group II (p=0.044 for $\chi^2$); for PCA – 42.1% versus 17.2% (p=0.017 for $\chi^2$) and 26.3% (p=0.305 for $\chi^2$).

Statistical analysis of the obtained data was carried out using the licensed program Statistica v.6.1®. The hypothesis of a normal distribution law for quantitative data was verified by the Kolmogorov-Smirnov criterion with the Lilliefors amendment. Under normal distribution, the quantitative indicators are presented as the mean and its standard error (M±m), in other cases the median and interquartile spread Me (25%, 75%) are given. Comparison of the average indicators in the clinical groups was carried out according to the appropriate Student (t) and Mann-Whitney (U) criteria, the relative indices were based on the Pearson Chi-square test ($\chi^2$) and the exact Fisher test. The relationship between the individual factors was evaluated using the Spearman rank correlation coefficient ($r_s$).
### Table 1

Degree of atherosclerotic lesion of MAH in patients with MFLV (n/%)

<table>
<thead>
<tr>
<th>Basin of the MAH</th>
<th>Number of cases</th>
<th>Degree of atherosclerotic lesion of the MAH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt;29%</td>
</tr>
<tr>
<td>Carotid basin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LICA</td>
<td>109/ 87.2</td>
<td>26/ 20.8</td>
</tr>
<tr>
<td>RICA</td>
<td>106/ 84.8</td>
<td>17/ 13.6</td>
</tr>
<tr>
<td>LCCA</td>
<td>26/ 20.8</td>
<td>9/ 7.2</td>
</tr>
<tr>
<td>RCCA</td>
<td>16/ 12.8</td>
<td>5/ 4.0</td>
</tr>
<tr>
<td>Left ECA</td>
<td>7/ 5.6</td>
<td>-</td>
</tr>
<tr>
<td>Right ECA</td>
<td>5/ 4.0</td>
<td>-</td>
</tr>
<tr>
<td>Left ACA**</td>
<td>1/ 1.1</td>
<td>-</td>
</tr>
<tr>
<td>Right ACA**</td>
<td>3/ 3,3</td>
<td>-</td>
</tr>
<tr>
<td>Left MCA**</td>
<td>1/ 1,1</td>
<td>-</td>
</tr>
<tr>
<td>Right MCA**</td>
<td>3/ 3,3</td>
<td>-</td>
</tr>
<tr>
<td>VA and BA basins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BA</td>
<td>2/ 1,6</td>
<td>-</td>
</tr>
<tr>
<td>LVA</td>
<td>35/ 28.0</td>
<td>1/ 0.8</td>
</tr>
<tr>
<td>RVA</td>
<td>28/ 22.4</td>
<td>2/ 1.6</td>
</tr>
<tr>
<td>LSA</td>
<td>6/ 4.8</td>
<td>-</td>
</tr>
</tbody>
</table>

*Notes: * - the data are presented as Me (25; 75 percentiles); ** - according to SCA in 89 patients, in other cases, according to Doppler ultrasonography and SCA in 125 patients.

According to the correlation analysis, there are likely associations of atherosclerotic lesion of the vessels of the MAH both between them, and with other risk factors. Thus, the presence of stenosis in LICA correlates with the frequency of cerebral infarcts (rs=0.25, p<0.01), including repeat (rs=0.20, p<0.05), the presence and severity of hypertension (HD) (rs=0.20, p<0.05), thickening of IMC (rs=0.27, p<0.01), lesion of LVA (rs=0.19, p<0.05). In atherosclerosis of RICA, thickening of IMC is more common (rs=0.24, p<0.05), stenosing process in LVA (rs=0.21, p<0.05) and RVA (rs=0.23, p<0.05). Atherosclerotic lesions of LCCA are also directly associated with the frequency of transient ischemic attacks (TIA) in LICA (rs=0.22, p<0.05), symmetric lesions of RCCA (rs=0.45, p<0.001) and presence of stenosis in Right ACA / Left ACA / Left MCA (rs=0.21, p<0.05). The lesion of RCCA is often combined with a high risk of recurrence of brain infarctions (rs=0.19, p<0.05), stenotic disturbances in LCCA (rs=0.45, p<0.001) and Right MCA (rs=0.28, p<0.01). In atherosclerotic lesion of vessels of the carotid basin, interconnected disorders in vessels of the basins of BA and VA are also correlated: the correlation coefficient between the presence of stenosis in LVA and LICA is rs=0.19, p<0.05, between LVA and RICA – rs=0.21, p<0.05, between RVA and RICA – r=0.23, p<0.05, between RVA and Left ECA – rs=0.20, p<0.05, between RVA and Right ECA – rs=0.28, p<0.01. With a brain infarctions in the vertebrobasilar basin, stenosis is more often associated with stenosis of the BA (rs=0.27, p<0.01).
Taking into account that the pathological deformations of ICA and VA with more pronounced levels (according to the criteria of tortuosity of ICA for Weibel-Fields and Metz, [3]) occupy a special place among the causes of ischemic cerebrovascular disorders (according to various data – in 24% of patients, in the presence of atherosclerotic lesions of the carotid arteries, among patients with various vascular diseases, the tortuosity of the internal carotid artery is from 31% to 58% [3, 4]), we analyzed the frequency of deformations and anomalies of the development of vessels in the carotid and vertebrobasilar basins in a general group of patients with MFLV and in clinical groups (table 2, fig. 2).

In the general group of patients with MFLV, vascular tortuosity was observed in basins of ICA and VA, and the frequency of vascular deformities of the vertebral-basilar basin dominated the deformations in the carotid basin (in LVA and RVA – 55.2% and 42.4%, respectively, as compared to LICA and RICA – 24.8% and 23.2%; p<0,01). Among spine arteries, deformity was more likely to be observed in the left VA – 55.2% versus 42.4% in the right VA (p=0.043 for $\chi^2$). Pathological deformations in LICA and RICA were found in equal ratios (table 2). The correlation analysis data show the symmetry of the changes of the main vessels of the carotid basin, the coefficient of correlation between the deformation of LICA and RICA is $r_s=0.69$, p<0.001, between LCCA and RCCA – $r_s=0.34$, p<0.001.

### Table 2

**Frequency of deformations and anomalies of development of carotid arteries in patients with MFLV (n/%)**

<table>
<thead>
<tr>
<th>Basin of the MAH</th>
<th>Number of causes</th>
<th>Deformations</th>
<th>Anomalies</th>
<th>Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carotid basin</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LICA</td>
<td>31/ 24.8</td>
<td>31/ 24.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RICA</td>
<td>29/ 23.2</td>
<td>29/ 23.2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LCCA</td>
<td>2/ 1.6</td>
<td>2/ 1.6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RCCA</td>
<td>4/ 3.2</td>
<td>4/ 3.2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>VA and BA basins</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LVA</td>
<td>83/ 66.4</td>
<td>69/ 55.2</td>
<td>7/ 5.6</td>
<td>7/ 5.6</td>
</tr>
<tr>
<td>RVA</td>
<td>74/ 59.2</td>
<td>53/ 42.4</td>
<td>16/ 12.8</td>
<td>5/ 4.0</td>
</tr>
</tbody>
</table>
In the analysis of the frequency of deformations / anomalies of ICA, VA in patients with clinical groups (fig. 2), the prevalence of disorders in patients of the group III was compared with the groups I and II: for LICA – 42.1% vs. 15.8% in group I (p=0.074 for $\chi^2$) and 23.0% for group II (p=0.087 for $\chi^2$); for RICA – 42.1% vs. 10.5% (p=0.027 for $\chi^2$) and 21.8% (p=0.066 for $\chi^2$); for bilateral lesion of VA – 73.7% vs. 42.1% (p=0.049 for $\chi^2$) and 60.9% (p=0.296 for $\chi^2$).

According to the results of the correlation analysis, the correlation between pathological deformations of ICA and VA and ischemic cerebrovascular accidents in patients with MFLV was established: between changes in RCCA and TIA in VBB - $rs=0.27$, $p<0.01$, between deformations of LVA and repeated brain infarctions – $rs=0.18$, $p<0.05$, between the tortuosity of RICA and TIA in RICA – $rs=0.23$, $p<0.05$.

**CONCLUSIONS**

1. In patients with ICD, a high incidence of stenosing lesion of the MAH is found, mostly in the carotid basin – 96.0%, including 87.2% in LICA and 84.8% in RICA, of which about half are hemodynamically significant stenosis or occlusion (51.2%);

2. Atherosclerotic vascular lesion of the basins of BA and VA is less frequently compared with carotid basin but is more pronounced (hemodynamically significant stenosis or occlusion – 64.8%; $p<0.05$);

3. The percentage of stenotic vascular lesion in the vertebrobasilar basin in patients with group I is more than twice as high as in patients with II and III group (except for RVA in group III) at $p<0.05$;

4. Probable associations of atherosclerotic lesion of vessels of the MAH with each other as well as with ischemic impairment of cerebral circulation in patients with MFLV (brain infarctions, TIA, HD) were established.

**REFERENCES**


Список літератури

1. Артеріальна гіпертензія і патологічна ізвитості сонних артерій / Г.В. Кок, П.В. Агафонов, Б.Б. Кок [та ін.]. // Вестник россійської воєнно-медичної академії. – 2016. – № 1. – С. 47-49.


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Залежність цитокінемії
Від клінічного перебігу
Хронічного обструктивного
Захворювання легень у поєднанні
З гіпертонічною хворобою

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Ключові слова: хронічне обструктивне захворювання легень, гіпертонічна хвороба, системне запалення, біомаркери, інтерлейкін-18, інтерлейкін-10

Key words: chronic obstructive pulmonary disease, hypertension, systemic inflammation, biomarkers, interleukin-18, interleukin-10