DOPPLEROGRAPHIC CHARACTERISTIC OF EXTRA-AND-INTRACRANIAL HEMODYNAMICS OF THE ACUTE CEREBRAL INFARCTION

The paper studies the characteristics of cerebral hemodynamic in patients with acute ischemic stroke using ultrasound diagnostics (dopplerography). It is shown that cerebral atherosclerotic genesis in patients occurs with the dominated diffuse decrease of cerebral hemodynamics and increased rigidity and vascular tone in carotid and extracranial vessels. Significant predominance of cerebral vessels occlusion, with appearances of average angiospasm and asymmetric blood flown in intracranial cerebral vessels, was found among patients with hypertension genesis.

Keywords: Extra-and-intracranial hemodynamics, acute stroke, dopplerographic characteristics.

UDC: 616.831-005.4-073.43

Introduction

The problem of the present-day pathogenic therapy of the acute cerebral blood flow disturbance is the most important in the clinical neurology due to high level of prevalence, lethality, disability and social adaptation of people affected by the cerebral infarction (Vereschagin and Piradov, 1999; Yahno and Vilenskiy, 2005). Brain is the main organ affected by the diseases of different etiology connected with cerebral and vascular complications (Gusev and Skvortsova, 2001).

Cerebral infarction happens as aftereffect of different pathological processes the main of which are arteriosclerosis and arterial hypertension (Skvortsova et al., 2006; Pokrovskiy, 1992; Myasnikov, 1965; Barhatov et al., 2006). Prognosis of peculiarities in disease dynamics and result of the acute cerebral blood flow disturbance can be of decisive importance in choosing of the first aid and secondary medical treatment (Shnaider and Vinogradova, 2003; Skvortsova, 2001). Complexity and multiple factors of development of ischemic infarctions stipulates the necessity of complex study of some aspects of their pathogenesis (Skvortsova, 2001). Disturbance of hemodynamic is an important issue in pathogenesis, clinical course and development of complications under the acute cerebral circulation disturbances (Skvortsova, 2001; Pavlovskaya, 1978). Progressive increase of numbers of cerebral infarction and its rejuvenation results from the increase of arterial hypertension and atherosclerosis which are the key factors of pathogenesis of acute cerebral circulation development. It is quite vividly nowadays that pathological organic affection of vascular wall goes in line with malfunction of hemodynamic in great vessels of the brain (Belkin et al., 2006; Gaidar et al., 2008; Yahno and Shtulman, 2003).

Due to the abovementioned, the goal of the current research is studying of peculiarities of cerebral hemodynamic under the acute ischemic disturbances of the cerebral blood circulation in case of the atherosclerosis and hypertension.

Data and methods of the research

100 patients with cerebral infarctions of hemisphere localization have been examined, acute cerebral blood flow disturbance (ACBFD) of atherosclerotic nature appeared as 35% and ACBFD of atherosclerotic and hypertension combination as 65%; 30 patients were included into the screening group. 41 patients had ischemic stroke in the area of the right medial cerebral artery and 59 in the area of the left medial cerebral artery. The
ischemic infarction patients consisted of 60 men and 40 women, the average age of the patients was 61.4±3.1. The average age of the screening group was 49±4.8.

All of the patients with the acute cerebral blood flow disturbance received the homogeneous basic undifferentiated and differentiated treatment of ACBFD. Undifferentiated therapy included dehydration by means of the loop diuretics (furosemide) and/or osmotic diuretics (glycerin), antihypertensive therapy (inhibitors of angiotensin-converting enzyme, calcium channel inhibitors), cardio-vascular medicine (electrolytes, cardiac glycoside), spasmylytic medicine (magnesium sulphate), antihypertensive medicine and antioxidants. Differentiated therapy of ischemic infarctions was directed into renewal of cerebral circulation (cavinton, pentoxifilin), improvement of rheological characteristic of blood (heparin, pentoxifilin), and others.

Condition of patients’ severity was evaluated based on two clinical scales - NIH Stroke Scale (Goldstein et al., 1989) and Scandinavian one (Scandinavian Stroke Study Group, 1985). Research doesn’t cover cases of high severity, in accordance with NIHSS clinical scales (not more than 29 scores) and Scandinavian scale (not less than 11 scores).

All patients underwent ultrasonic and dopplerography of brachycephalic trunk examination (UDBT) of common carotid artery (CCA), internal carotid artery (ICA) and supratrochlear artery, including transcranial dopplerography examination (as well as study of hemodynamic of medium cerebral artery (MCA), anterior cerebral artery (ACA) and posterior cerebral artery (PCA) by using “LOGIDOP-4” device (made by “Kransbuchler”, Germany) equipped with 2.4 and 8 MHz sensor identifying linear and average blood circulation velocity, and Purselo (RI) and Gosling (PI) indexes. Evaluation of extracranial sectors of carotid artery was carried out by means of functional test - carotid compression test.

Research results

The main neurological occurrence of ischemic hemisphere infarction have been characterized by the prevailed focal signs: central paralysis of the VIIth and XIIth nerves, mono- and hemiparesis or hemiplegia, occurrence of pathological reflexes, reflexes of oral automatism in combination with sensitivity disorders in form of surface or total monon- and hemianesthesia. Affection of dominating hemisphere was accompanied by disorder of higher cortical functions. The average clinical score under the registration of patients with cerebral infarctions appeared as 20.4±1.7 based on NIHSS scale and 27.8±2.3 as per the Scandinavian one, what is in both cases the moderated severe level of the disease.

Studying of the age and sexual structure of the disease demonstrates that acute cerebral blood flow disturbance (ACBFD) of atherosclerotic nature affects more the old men, and ACBFD of the hypertensive nature affects the young men and women.

Ultrasonic examination of carotid extracranial arteries showed stenotic lesion prevailing within the internal carotid artery (ICA), atherosclerotic changing of the curve, vasomotor spasm symptoms and decline in vessels’ reactivity. Signs of the internal carotid artery stenosis included: increase of the blood flow velocity in bifurcation area; presence of turbulent blood flow; decline in blood flow velocity in common and/or internal carotid artery by 30% and more in comparison with contralateral arteries; decrease of diastolic component of the blood flow velocity in the common carotid artery (CCA) in comparison with contralateral part; 40% decrease in blood flow velocity in supratrochlear artery and more in comparison with contralateral part; appearance of the retrograde blood flow in supratrochlear artery under the compression of 1-2 with homolateral common carotid artery; blood flow velocity decrease in supratrochlear artery under the compression of homolateral and/or superficial temporal artery; no decrease of blood flow velocity in supratrochlear artery under the carrying out of superciliary test of hemodynamics; no change of blood flow velocity in supratrochlear artery under the compression of homolateral superficial temporal or facial artery under the blood flow
increase reaction in contralateral artery during the compression of these arteries at the similar side; changing of spectral characteristic of blood flow in carotid artery.

Ultrasonic and Dopplerography examination of carotid braheocephalous vessels demonstrated diversified Ultrasonic and Dopplerographic results and was specific for each of the examined groups of the patients (Table 1).

### TABLE 1. DOPPLEROGRAPHIC PERFORMANCES OF EXTRACRANIAL HEMODYNAMIC OF THE EXAMINED PATIENTS

<table>
<thead>
<tr>
<th>The examined groups</th>
<th>Artery</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GS. cm/sec</td>
<td>PI</td>
</tr>
<tr>
<td><strong>Screening group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n=30)</td>
<td>CCA</td>
<td>88.3±10.5</td>
</tr>
<tr>
<td></td>
<td>ICA</td>
<td>78.4±12.6</td>
</tr>
<tr>
<td></td>
<td>SA (supratrochlear artery)</td>
<td>54.5±7.8</td>
</tr>
<tr>
<td><strong>Atherosclerotic stroke</strong></td>
<td>CCA</td>
<td>65.6±4.2*</td>
</tr>
<tr>
<td>(n=35)</td>
<td>ICA</td>
<td>51.8±3.98*</td>
</tr>
<tr>
<td></td>
<td>SA</td>
<td>30.8±4.8*</td>
</tr>
<tr>
<td><strong>Combination of atherosclerosis and hypertension</strong></td>
<td>CCA</td>
<td>60.4±5.4*</td>
</tr>
<tr>
<td>(n=65)</td>
<td>ICA</td>
<td>45.6±5.7*</td>
</tr>
<tr>
<td></td>
<td>SA</td>
<td>27.6±4.1**</td>
</tr>
</tbody>
</table>

*Note: reliability of performances in regards to the norm was noted: * (P<0.05); ** (P<0.01);*

Atherosclerotic ACBFD have been accompanied by the diffuse atherosclerotic changing of CCA and ICA dopplerographic curve with the considerable reduce of linear blood flow velocity, increase of rigidity of vessel wall. In this group of patients the stenotic changes of vessels walls in most cases happened both in CCA and ICA. Stenosis reached critical rate in 28.6% of the cases. 71.42 % of patients with atherosclerotic ACBFD had low activity of the vessels during the compression test. Decrease of linear blood flow velocity by more than 30% was found in 23 of 35 cases, CCA, ICA and supratrochlear artery were affected at most of the patients. 8.57% of the patients had retrograde blood flow, and 34.28% had antegrade blood flow changed into the retrograde one in response to the compression test. It was noted that quite often in this group (40.0% of the patients) higher stenosis of extracranial carotid trunks was more at the opposite side from the affected hemisphere. This group of the examined patients had a statistically significant increase of Purselo (more than by 40%) and Gosling (more that by 70%) coefficients, what evidenced the increase of resistance in regards to the blood flow and increase of the periphery resistance and brachycephalic trunk rigidity.

Under the combination of atherosclerosis and hypertension at the acute cerebral blood flow disturbance, the ultrasonic and Doppler examination demonstrated the early stenotic changes which were often located within the internal carotid artery, prevailing from one of the sides and accompanying with a moderate two-sided vasomotor spasm. This group more often included hemodynamic stenosis leading to the occlusion of extracranial carotid brachiocephalic trunk. Reactivity of vessels in this group of patients was in most cases lowered. Retrograded blood flow in supratrochlear artery was recorded in 20% of the studied cases, and in 60% of the studied cases the antegrade blood flow after the compressive test changed in the retrograded direction with the significant hemodynamic decrease of blood flow velocity in supratrochlear artery and moderate increase of the vascular tone.

Here is the clinical observation.

Patient named B., 60 years old. Diagnosis: Cerebral vascular disease. The acute disturbance of cerebral blood flow of ischemic nature, in medium cerebral artery of the right hemisphere with left-sided hemisyndrome developed as a result of atherosclerosis of cerebral vessels and hypertension.

Patient was hospitalized to the department of intensive neurology. He complained of a weakness and numbness in left extremities, headache and giddiness.
Impartial observations: systolic noise over the carotid arteries from both sides was auscultated.

Results of dopplerographic examination: Retrograded blood flow in supratrochlear artery was recorded; it was disappearing under the compression of homolateral CCA. Under the compression of homolateral surface of temporal artery blood flow partially reduces. Linear blood flow velocity in the left ICA is significantly intensified up to 250 cm/sec, it was impossible to check condition in ICA on the right. Periphery type of curve was recorded in the common carotid arteries. Blood flow is aggravated in vertebral arteries from both sides and the main artery, what evidences the compensation of blood circulation by means of carotid arteries and system of vertebral arteries. The velocity of blood flow in the right MCA is increased by 34cm/sec and in the left CMA by 40 cm/sec. Blood flow in the anterior cerebral artery from both sides was not subject to location detection. An intensive blood flow is recorded in posterior cerebral artery and it becomes more intensive under the compression of homolateral MCA.

Based on the above mentioned conclusion was made as follows: signs of occlusion of the right ICA; hemodynamically important stenosis of the left ICA. Diagnosis was confirmed after the angiography. Source of the collateral blood flow: it was originated from the vertebral basilar system and extra and intracranial anastomosis through the eye artery.

**Figure 1. Patient B. Retrograde type of blood flow in the right supratrochlear artery**

**Figure 2. Patient B. Peripheral type of curve in the common carotid arteries**
When cerebral stroke is accompanied with atherosclerosis and hypertension according to the statistic records such signs as asymmetry of blood flow with hypoperfusion in the affected area are prevailing (p<0.05). In 45.71% cases there were local changing of blood flow with turbulence signs, moderate increase of linear blood flow velocity at ACA (anterior cerebral artery) considerably increasing under the compression of contralateral CCA (common carotid artery), and considerable increase of linear blood flow velocity at PCA (posterior cerebral artery) under the compression of homolateral CCA with lowering of MCA (medium cerebral artery) after the compressive test. In 7.69% of cases there was recorded absence of blood flow at MCA or presence of residual blood flow. 26.15% patients suffering from the acute blood flow disturbance accompanied with
Atherosclerosis and hypertension had moderate increase of the linear blood flow velocity with the increase of the peripheral resistance and vascular tone index.

**Conclusion**

The results of the undertaken researches demonstrated considerable difference in hemodynamic performances of extracranial vessels of the carotid area in case of the acute cerebral blood flow disturbance of different etiology. Thus, in case of the atherosclerotic lesion the diffusive decrease of blood flow velocity in the carotid brachiocephalic trunks dominates under their stenotic lesion of the diffusive two-sided nature and increase of rigidity and tone of vessels. The diffusive decrease of blood flow velocity against the growth of rigidity of the vessel wall prevails in intracranial vessels. When atherosclerosis was accompanied with hypertension, the acute blood flow disturbance was in line with the early development of stenotic changes with the statistically significant prevailing of the occlusive lesion and signs of the moderate vasomotor spasm. Intracranial perfusion was characterized by the asymmetry of blood flow with hypoperfusion in the affected area.

**References**


