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Haemodynamic Changes in the Extracranial Carotid Vessels in Acute Ischemic Strokes of Various Etiologies

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The complexity and multifactorial nature of the development of ischemic strokes necessitate a comprehensive study of some aspects of their pathogeneses.
The purpose of the study was to examine the patterns of extracranial cerebral blood vessel hemodynamics in acute ischemic strokes: - cardioembolic, atherosclerotic, and lacunar infarctions. Material and methods: we examined 90 patients with ischemic strokes of cerebral hemispheric localization, of which 25 (27.5%) had a cardioembolic stroke, 35 (38.9%) had a stroke of atherosclerotic origin, and 30 (33%) had a lacunar stroke. Thirty (30) examined people made up the control group. Results: the main neurological manifestations of hemispheric ischemic stroke were characterized by the predominance of focal symptoms: central paresis of the 7th and 12th nerves,

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the presence of mono-, hemiparesis or hemiplegia, the appearance of pathological reflexes, reflexes of oral automatism, combined with sensory disorders in the form of superficial or total mono and hemianesthesia. In patients with lacunar stroke, signs of diffuse vasospasm of the BCV (brachiocephalic vessels) predominated (83.29%), ipsilateral to the affected hemisphere with an increase in the level of blood flow velocity (BFV) and intima media complex (IMC), as well as the level of peripheral resistance and vascular tone. Hemodynamically significant signs of stenosis were detected in 6.58% of this group. Conclusion: the results of the studies indicate that strokes of cardioembolic and atherosclerotic origins are associated with significant haemodynamic changes and in lacunar stroke, thechanges are surprisingly significant. Therefore, there is a need to put this into consideration while treating acute ischaemic strokes.

Keywords: Doppler ultrasound; extracranial vessels; head hemodynamics; acute ischemic strokes.

1. INTRODUCTION

According to international epidemiological studies, strokes occupy a leading place in the structure of both mortality and disability of the population and are a serious medical and socio-economic problem for society [1-5]. Despite the etiological diversity of the pathology of the main extracranial vessels in diabetes mellitus, rheumatism, hypertension, and atherosclerosis, they often end in the development of such a serious complication as acute cerebrovascular accident [6-10]. It is now obvious that pathological organic lesions of the vascular wall are accompanied by hemodynamic disturbances in the main extracranial vessels of the brain [11-16].

The purpose of the study was to study the features of extracranial cerebral hemodynamics in acute ischemic disorders of cerebral circulation - cardioembolic, atherosclerotic, and lacunar infarctions.

2. MATERIALS AND METHODS

We examined 90 patients with ischemic strokes of hemispheric localization, of which 25 (27.5%) had cardioembolic stroke, 35 (38.9%) had stroke of atherosclerotic origin, and 30 (33%) had lacunar stroke. 30 examined people made up the control group. In 38 patients, ischemic stroke was diagnosed in the territory of the right middle cerebral artery, in 52 – in the territory of the left middle cerebral artery. Among the patients with ischemic strokes, there were 43 men and 17 women, whose average age was 51-53 years. The average age of the control group was 46-48 years.

The severity of the patients was assessed using two clinical scales: NIHSS (National Institute of Health Stroke Scale).The study did not include very severe stroke patients, according to the NIHSS (no more than 29 points) and Scandinavian (no less than 11 points) clinical scales. All examined patients underwent Doppler ultrasound of the brachiocephalic vessels (USDG BCV) along the common carotid arteries (CCA), internal carotid arteries (ICA), and external carotid arteries (ECA) arteries using the Phillips affinity 70 apparatus (Germany), Mindray DS-80 with a sensor with a frequency of 5-12 MHz with determination of linear blood flow velocity (LBV) and middle wall (IWM), Purcelot index (RI) and Gosling index (PI). Assessment of patency in the extracranial part of the carotid arteries was carried out using a functional test—carotid compression test [17-20].

3. RESULTS AND DISCUSSION

The main neurological manifestations of hemispheric ischemic stroke were characterized by the predominance of focal symptoms: central paresis of the 7th and 12th nerves, the presence of mono-, hemiparesis or hemiplegia, the appearance of pathological reflexes, reflexes of oral automatism, combined with sensory disorders in the form of superficial or total mono and hemianesthesia. Damage to the dominant hemisphere was also accompanied by disturbances in higher cortical functions. The average clinical stroke score was 19.5+1.6 on the NIHSS scale and 28.5+2.4 on the Scandinavian scale, which in both cases corresponds to the average severity of the disease.

A study of the age and gender structure of morbidity showed that women are more susceptible to cardioembolic stroke, and older men are more susceptible to atherosclerotic stroke. Young men are more affected by lacunar strokes.

Ultrasound examination of the carotid arteries revealed stenotic lesions mainly in the ICA basin, atherosclerotic changes in the curve, signs of vasospasm, and decreased vascular reactivity. Signs of ICA stenosis were: increased blood flow velocity in the bifurcation area; the presence of turbulent blood flow; decrease in blood flow velocity in the common and/or internal carotid artery by 30%. Decrease in the diastolic component of blood flow velocity in the CCA; decrease in blood flow velocity through the external carotid artery with compression of the homolateral and/or superficial temporal artery; no decrease in blood flow velocity in the external carotid artery when performing a brow hemodynamic test; no changes in blood flow velocity in the external carotid artery during compression. (6-8c) homolateral superficial temporal or facial artery in the presence of a reaction of increased blood flow in the contralateral artery during compression of the same arteries on the same side; change in the spectral characteristics of blood flow through the carotid artery.

The ultrasound examination of the carotid brachiocephalic vessels showed a varied ultrasound picture and was unique for each of the examined groups of patients (Table 2).

Atherosclerotic strokes were accompanied by diffuse bilateral atherosclerotic changes in the Doppler curve of the CCA and ICA with a significant decrease in the level of LSC and IMT, and an increase in the rigidity of the vascular wall. In this group of patients, stenotic changes in most cases affected both the CCA and the ICA. The degree of stenosis reached critical values in 31.57% of patients. In 77.14% of patients with atherosclerotic stroke, a decrease in vascular reactivity in response to a compression test was detected. A decrease in the linear velocity of blood flow by more than 30% was found in 23 patients out of 35; in most of them, this decrease affected both the CCA, ICA, and ECA. In 8.57% of patients, the direction of blood flow along the ECA artery was retrograde, and in 57.14% of patients, in response to a compression test, antegrade blood flow changed to retrograde. Quite often (42.86%) in this group, the degree of stenosis of the extracranial carotid bifurcations was to one degree or another greater on the side opposite to the affected hemisphere. In this group of subjects, there was a statically significant increase in the Purcelot index (by more than 40%) and the Gosling index (by more than 70%), which indicates an increase in blood flow resistance and an increase in peripheral resistance and rigidity of the BCV.

Table 1. Patients with ischemic strokes (n=60)

	Patients with ischemic strokes (n=60)		
	1 group (n=25)	**2 group (n=35)**	**3 group (n=30)**
NIHSS scale, points	20,3±1,9	21,2±2,4	18,6±2,1
Scandinavian scale, points	25,1±2,7	27,9±2,5	30,1±2,6

Table 2. Dopplerographic indicators of the examined

Surveyed group	**Arteries**	**Parameters**		
		GS, sм/c	**PI**	**RI**
Control group (n=30)	**CCA**	65,9±11,5	1,40±0,37	0,68±0,18
	ICA	59,3±14,3	0,96±0,34	0,59±0,12
	ECA	76,4±18,3	1,29±0,45	0,63±0,16
Atherosclerotic stroke (n=35)	**CCA**	61,4±5,3	2,49±0,40	1,25±0,22
	ICA	47,4±5,8	2,14±0,30	1,23±0,22
	ECA	70,8±4,8	1,58±0,33	1,05±0,19
Lacunar stroke (n=30)	**CCA**	160±19,5	2,51±0,41	1,35±0,28
	ICA	138±18,7	2,15±0,32	1,35±0,28
	ECA	100±11,8	2,00±0,36	1,19±0,16
Cardioembolic stroke (n=25)	**CCA**	122,5±10,3	2,20±0,32	1,18±0,24
	ICA	108,9±5,1	2,25±0,40	1,18±0,12
	ECA	74,6±4,2	2,15±0,53	1,14±0,17

*Note: the reliability of the indicators in relation to the norm was noted *(P < 0.05), ** - (P < 0.01)*

In case of cardioembolic stroke, ultrasound doppler examination was characterized by the early development of gross stenotic changes, which were more often localized in the internal carotid artery, prevailed on one side or the other, and were accompanied by moderate bilateral vasospasm. In this group, hemodynamic significant stenoses were most common, often reaching the degree of occlusion of extracranial carotid bifurcations, which is statistically significantly higher than the incidence of occlusive lesions in patients with stroke with arterial hypertension and atherosclerotic origin. Vascular reactivity in this group of patients was reduced in the majority. In 20% of cases, retrograde blood flow was recorded according to the carotid test; it changed in the retrograde direction with a hemodynamically significant decrease in blood flow velocity in the external carotid artery and a moderate increase in the level of vascular tone.

In patients with lacunar stroke, signs of diffuse vasospasm of the BCV predominated (83.29%), with a predominance on the side of the affected hemisphere with an increase in the level of blood flow velocity and intima media complex well as the level of peripheral resistance and vascular tone. Hemodynamically significant signs of stenosis were detected in 6.58% of this group. Vascular reactivity in response to the compression test was preserved in the majority of patients with symptomatic arterial hypertension. A change from antegrade blood flow in the external carotid artery to retrograde in response to a compression test was recorded in 36.6% of cases.

4. CONCLUSION

Thus, the results of the study showed significant differences in hemodynamic parameters in the extracranial vessels of the carotid system in strokes of various etiologies. Thus, with atherosclerotic lesions, a diffuse decrease in the speed of blood flow along the carotid BCAs is dominant in the presence of their stenotic lesions of a diffuse bilateral nature, with an increase in the rigidity and tone of the examined vessels. Cardioembolic stroke was accompanied by the early development of stenotic changes, with a statistically significant prevalence of cases of occlusive lesions with signs of moderate bilateral vasospasm. Early and gross changes in the carotid BCs indicate involvement of the extracranial brachiocephalic great arteries in the inflammatory process.

The results obtained indicate the need to develop differentiated treatments of stroke depending on the pathogenesis of the disease, taking into account the mechanism of stroke development. Timely diagnosis of hemodynamic parameters helps reduce the development of cerebrovascular complications.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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