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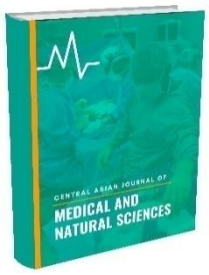

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Ultrasonic Dopplerography of Retinal Vessels in Acute Cerebral Ischemia Against the Background of Arterial Hypertension

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Annotation: Comprehensive diagnosis of vascular diseases of the brain is based on the joint use of methods of radiation and ultrasound diagnostics. At the same time, the leading place is occupied by ultrasound assessment of blood flow in the cerebral arteries as the most mobile method of screening, dynamic observation and monitoring of the condition of patients with acute cerebrovascular insufficiency. And absolute or relative circulatory failure damages the substance of the brain.

Keywords: vascular diseases, failure damages, ultrasonic dopplerography, retinal vessels, arterial hypertension, ischemia.

Introduction. The significance of the damaging effect of ischemia is determined by the degree and duration of the decrease in cerebral blood flow to a critical threshold, as well as the degree of functional activity during the period of perfusion insufficiency. It is optimal if the decrease in perfusion is short-term (spasm, loose thrombus, collapse, hemodynamic mismatch, etc.) or occurs against the background of occlusion of the main artery of the brain, in which a dense collateral network quickly begins to work (compensatory hyperemia). In these cases, cerebral blood flow fully or partially returns to the ischemic area and the degree of ischemic changes does not reach a critical level. In addition to direct acute perfusion deficit against the background of thrombosis, reperfusion injury plays a significant role in damage to the brain substance during partial or complete revascularization of the blocked segment of the arterial bed of the brain (thrombosis , thrombectomy , spontaneous recanalization , etc.). With all the variety of pathogenetic variants of damage to the cerebral vascular bed there are several diagnostically important parameters of the Doppler signal, the changes of which are universal and reproducible, - the direction of the flow in relation to the source of ultrasonic radiation, the type of spectrum, the value of the maximum systolic and minimum diastolic velocity . blood circulation is possible only within the anatomical location of the cerebral arterial formations, which have an efferent distribution of flows in relation to the heart. In the case of an obvious problem with blockage or gross stenosis , the flow directions change in accordance with the capabilities of the collateral system, and preference in the evaluation of dopplerograms , as a rule, is given to the qualitative characteristics of the spectrum: shape, frequency distribution, direction and sound phenomena. The main signs of pathology are the distortion of the spectral profile (turbulence, filling of the spectral window, deformation of the systolic - diastolic complex) or the presence of "pathological overflows ".

The quantitative assessment of blood flow in the arteries of the brain is based both on directly measured Dopplerogram parameters (amplitude, frequency distribution, impulse variations) and on various calculated indices.

The most demanded measured Doppler parameter is the flow velocity:

- systolic velocity maximum (Vsist);
- end diastolic velocity (Vdiast);
- average speed per cardiac cycle (MenV);
- average speed per systole (Vms).

The flow rate is a reference value for arterial vessels with certain, close to constant characteristics (diameter, depth). Initially, it is assumed that in the absence of anomalies in the structure and diseases of the vessels that form the cerebral arterial system, the absolute values of blood flow parameters at rest are constant for a particular person, and their deviations during functional loads (hypoxia, physical activity, etc.) correspond to the range of the autoregulation reserve .

Based on the indicated parameters characterizing the spectral curves, calculated coefficients have been developed that allow one to quantitatively describe the normal and pathological features of the received signal. The most commonly used for clinical assessment of blood flow parameters are:

- circulatory resistance index (RI);
- pulsation index (PI);
- systole -diastolic ratio (ISD);
- spectral broadening index (SBI);
- asymmetry coefficient (KA);
- pulse wave rise index (PWI).

A close relationship between an increase in the degree of arterial stenosis and the risk of stroke has been proven, while a significant increase in the linear velocity of blood flow becomes the main diagnostic argument when performing blind ultrasound diagnostics. The world experience in studying the speed parameters of cerebral arterial blood flow makes it possible to consider the normative values of these parameters for all segments of the cerebrovascular system, and consider deviations of the measured parameters from the average statistical values in the population as a quantitative sign of the actual pathology. Thus, an increase in the quantitative indicator of blood flow velocity in the diagnosis of arterial lumen narrowing in the range from 20 to 70% is of paramount importance, since there are still no obvious distortions of the spectrum pattern in this range . And the absolute values of blood flow velocity play an important role in assessing the reserve of collateral circulation or calculations transmission pulsation index (the ratio of velocities in the extra- and intracranial segments of the arteries of the carotid basin) with cerebral vasospasm . In addition, all judgments about the quantitative values of the tonic component of the located vessel, the state of the resistive segment of the cerebral arterial basin and reactive changes during the period of functional stress are also derivatives of the analysis of the velocity parameters . -less clear stages of decrease and increase in the level of qualitative and quantitative parameters in accordance with the laws of hemodynamics and pathological anatomy (cyst formation). At the same time, it is not possible to identify a significant correlation between the severity of stroke and the weighted average rate, RI, PI, ISD, SBI, IPPV (without taking into account age characteristics). This makes it possible to refuse monitoring of these parameters in dynamics in patients with an orientation to the degree of neurological deficit [1–4]. The overall outcome of a stroke depends on the severity of hypoperfusion (decrease in linear velocity) at the onset

of the disease in extracranial vessels. In addition, for an approximate prediction of the outcome of ischemic stroke on the National Institutes of Health Stroke Severity Scale (National institutes of Health Stroke Scale - NIHSS) and the modified Rankin scale (modified Rankin Scale - mRs), linear velocities in the middle (Vsist , Vdiast) and anterior (Vsist , Vdiast , MenV) cerebral arteries can be taken as the target monitoring point. It is also known that there is no significant correlation between the parameters of blood flow in the posterior cerebral arteries and the basilar (main) artery and the severity of neurological deficit [5].

The category of patients older than 60 deserves special attention. With age, the elastic -tonic properties of blood vessels change, there is a tendency to slow down the linear velocities of blood flow, which reduces the possibility of adequate autoregulation . Therefore, the analysis of ultrasonic indices characterizing the functional state of blood flow (RI, PI, ISD) is more applicable to this category of patients. If, when analyzing the dynamics of these parameters, in persons under 60 years of age, high PI and ISD values are noted in the middle cerebral artery, then in persons over 60 years of age, permanently high RI values are observed at the extracranial level (common carotid artery, internal carotid artery, vertebral arteries) and in middle cerebral artery. However, when analyzing ISD, the indicators are usually higher than the normative values in all patients, which does not give reason to choose this parameter as the goal of long-term ultrasound monitoring . Nevertheless , when performing systemic thrombolysis , the importance of this parameter can hardly be overestimated.

Persons over 60 years of age are characterized by a decrease in the linear velocity of blood flow in the vertebral arteries by the end of the acute period of ischemic stroke. Although this decrease occurs within reference values, in many cases hypoperfusion (more than 50%) and stroke are found in the vertebrobasilar basin, which implies the need to monitor blood flow in this area. This can also be considered the basis for taking the outcome of the third week as a control point for monitoring in acute cerebrovascular accidents in this age group of patients.

Features of the restructuring of cerebral circulation in the acute stage of ischemic stroke, identified using ultrasound diagnostics, at one time made it possible to propose a protocol for monitoring cerebral blood flow, taking into account , first of all, its subtype [1, 4]. It reflects the range of dynamic parameters and target points that are appropriate to use for monitoring cerebral blood flow in patients with acute cerebral ischemia, taking into account the pool, severity, outcome, and subtypes of stroke, taking into account the heterogeneity of its nature (Fig. 1). In this case, we can speak more about functional segmental changes than about atherosclerotic manifestations. In this regard , Doppler ultrasound of the vessels of the head and neck can be a more informative diagnostic method than duplex scanning in verifying dynamic blood flow disorders. However, ultrasound examination may provide a clearer picture of the dynamics of the hemodynamic subtype of ischemic stroke, especially in diagnosed degenerative dilated stroke. arteriopathy .

In the case of detection of deviations of speed parameters from the reference values both with standard ultrasonic dopplerography in dynamics and with prolonged monitoring using ultrasonic dopplerography, it is proposed to resort to the protocol of diagnostic measures presented in Fig. 2 [6, 7].

Conclusion

Turning to the absolute values, one should take into account some features of the distribution of velocity parameters in the cerebral arteries, due to a combination of physiological and instrumental reasons. These features are manifested by the physiological hierarchy of the values of the linear velocity of blood flow in the cerebral and precerebral arteries. At the extracranial level: internal carotid artery > external carotid artery > vertebral artery. On the intracranial level: middle cerebral artery > anterior cerebral artery > internal carotid artery > posterior cerebral artery > basilar artery > vertebral

artery falls within the 20% range . The flow in the basilar artery is fundamentally always higher than in the best of the vertebral arteries. The normative value of the coefficient of asymmetry between the same-named arteries of the carotid basin should not exceed 20%, for the vertebral arteries a 30% difference in speed indicators is acceptable. Taking into account the anatomical features (the formation of the right arterial sections from the brachiocephalic trunk), lower values are more often recorded in the right vertebral arteries and the internal carotid artery.

Against the background of positive neurological dynamics, by the end of the fourth week of the disease, most patients experience both a general and a regional decrease in speed indicators, which is associated with overcoming edema, a decrease in the volume of brain tissue in the affected area, restoring the correspondence of perfusion capabilities to the metabolic and functional needs of the remaining areas of the brain. brain. Prolongation of the period of instability of speed parameters or significant fluctuations in absolute values can serve as a marker of an unfavorable prognosis for the deepening of the ischemia process (progressive course) or the development of a recurrent stroke, which undoubtedly serves as the basis for clarifying the etiological and / or pathogenetic factor, searching for errors in the choice of treatment tactics . in patients with moderate and severe stroke with severe regional disorders of cerebral circulation against the background of steno-occlusive lesions of the main arteries of the head, an additional target for monitoring can be the flow rate in the compensating arterial segment of the donor pool. According to the dynamics of blood flow velocity in this segment, one can judge the stabilization of ischemic disorders or the threat of deterioration in the symptomatic vascular region . In acute cerebral ischemia, cerebral blood flow velocity can act as a prognostic marker and monitoring goal. The linear blood flow velocity is more informative in dynamic observation, it demonstrates the autoregulatory reserve and the effectiveness of therapeutic efforts during the acute period . With the tratification of normative values with the allocation of suprathreshold deviations of velocity parameters, it is possible to increase the sensitivity of the ultrasound assessment of cerebral blood flow with the greatest information content by the end of the acute period of ischemic stroke. When comparing the threshold values with the obtained indicators, it is possible to identify individuals with an increased risk of deterioration or death, requiring correction of therapy or expansion of the diagnostic program.

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