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CEREBRAL HEMODYNAMIC ALTERATIONS IN MIGRAINE-ASSOCIATED ISCHEMIC STROKE ACCORDING TO DOPPLER ULTRASONOGRAPHY

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Abstract: Migraine-associated ischemic stroke (MAIS) represents an important and increasingly recognized subtype of cerebrovascular pathology, predominantly affecting young and middle-aged individuals, especially women. The pathophysiological mechanisms underlying this condition include endothelial dysfunction, vasospasm, impaired autoregulation, and disturbances in cerebral perfusion. Despite significant advances in neuroimaging, early identification of hemodynamic disturbances remains a critical challenge. Doppler ultrasonography (USDG) of cerebral vessels is a widely available, non-invasive diagnostic method that allows real-time assessment of blood flow parameters and vascular resistance. Its role in detecting early cerebrovascular alterations in migraine-associated stroke requires further clarification, particularly for identifying patients at increased risk of ischemic complications.

Objective. The aim of this study was to investigate cerebral hemodynamic changes in patients with migraine-associated ischemic stroke using Doppler ultrasonography and to evaluate their clinical and diagnostic significance.

Materials and Methods. The study included 110 patients aged 19 to 45 years. The main group consisted of 65 patients diagnosed with migraine-associated ischemic stroke according to ICD-10 criteria (G43.3), while the comparison group included 45 patients with migraine with aura (G43.1). A control group of 30 healthy individuals matched by age and sex was also included. All participants underwent comprehensive clinical and neurological evaluation. Doppler ultrasonography was performed to assess linear blood flow velocity (LBFV) and resistance index (RI) in major cerebral vessels, including the internal carotid arteries (ICA), middle cerebral arteries (MCA), vertebral arteries (VA), and the basilar artery (BA). Statistical analysis was conducted using Student's t-test, Welch's correction, and chi-square test.

Results and discussion. Doppler ultrasonography revealed significant alterations in cerebral hemodynamics in patients with migraine-associated ischemic stroke. A tendency toward decreased linear blood flow velocity was observed in several major vessels, particularly in the right internal carotid artery (40.1 ± 7.4 cm/s), the left vertebral artery (29.6 ± 4.9 cm/s), and the basilar artery (37.3 ± 5.4 cm/s). These findings indicate reduced cerebral perfusion, which may contribute to increased ischemic vulnerability in this patient population.

At the same time, increased resistance indices were identified in the vertebrobasilar system, suggesting elevated peripheral vascular resistance and impaired vascular elasticity. Statistically significant differences between groups were found in the linear blood flow velocity in the left vertebral artery ($p = 0.033$) and basilar artery ($p = 0.014$), as well as in resistance indices in vertebral arteries ($p < 0.001$). These results reflect disturbances in vascular tone regulation and support the role of vasospastic mechanisms in the development of migraine-associated stroke. Additionally, structural vascular abnormalities were detected, including a higher prevalence of stenosis and occlusion of the internal carotid arteries in the main group (up to 55.4%). These findings suggest that both

functional and structural vascular changes contribute to the pathogenesis of the disease.

In contrast, patients with migraine with aura demonstrated hemodynamic parameters close to normal reference values, indicating that significant vascular disturbances are more characteristic of migraine-associated stroke. The observed alterations may also be associated with endothelial dysfunction, supported by elevated endothelin-1 levels identified in laboratory studies. Thus, Doppler ultrasonography provides important information about cerebral blood flow disturbances and can be considered a valuable tool for early diagnosis, monitoring, and risk stratification in patients with migraine-associated ischemic stroke.

Conclusions. The results of the study demonstrate that migraine-associated ischemic stroke is accompanied by significant disturbances of cerebral hemodynamics, manifested by decreased linear blood flow velocity and increased peripheral vascular resistance, reflecting impaired vascular tone regulation and disrupted cerebral autoregulation. These Doppler findings have both diagnostic and prognostic value, as they may serve as early markers of ischemic complications in patients with migraine. The use of Doppler ultrasonography in clinical practice allows timely identification of high-risk patients and optimization of preventive and therapeutic strategies aimed at reducing the incidence of migraine-associated stroke.

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