Case analysis of crossed cerebellar hemispheric diaschisis in acute stroke patients

Abstract. Background. Stroke is the second-leading global cause of death behind the heart disease, accounting for 11.8% of total deaths worldwide. The Monakow concept of diaschisis describes neurophysiological changes that occur distant to a focal brain lesion. Diaschisis plays a significant role in the severity of acute neurological deficit and spontaneous stroke recovery. However, currently there are not enough published prospective hospital-based cohort studies that report and analyze clinical characteristics of crossed cerebellar hemispheric diaschisis in acute stroke patients. The purpose of this study is to determine the features of the clinical manifestations of crossed cerebellar hemispheric diaschisis after acute cerebral stroke and to improve the efficiency of its diagnosis by comparing the obtained data with the results of the magnetic resonance imaging. Materials and methods. We prospectively recruited 124 acute stroke patients, who were admitted to a single department at an academic tertiary care hospital in Kyiv, Ukraine. The primary outcome was the combined incidence of stroke and diaschisis. In the secondary analyses, we evaluated pathophysiological, anatomical, and clinical features specific to crossed cerebellar hemispheric diaschisis in a cohort of acute stroke patients. Results. Among 124 selected acute stroke patients admitted to the department, 42 (33.9%) persons were diagnosed with different forms of diaschisis. Crossed cerebellar hemispheric diaschisis was diagnosed in 6 patients. We described clinical manifestations and analyzed pathophysiological and clinical features of crossed cerebellar hemispheric diaschisis in acute stroke patients. The main mechanism of crossed cerebellar hemispheric diaschisis is an interruption of efferent impulses at the cerebellar dentate or dentate-thalamo-cortical pathway. Conclusions. Consequently, isolated cerebellar infarctions were manifested not only in ataxic disorders, but also in motor and sensory impairments due to the damage of the frontal-parietal cortex (diaschisis) of the opposite hemisphere of the brain.

Keywords: crossed cerebellar hemispheric diaschisis; cerebellar stroke; cerebellum; distant diaschisis; forms of diaschisis; clinical manifestations; diagnosis, case report
trained in cerebrovascular diseases. All participants underwent standardized investigation to obtain: clinical history, 12-lead electrocardiogram, blood testing, carotid ultrasound, head computed tomography (CT) and brain magnetic resonance imaging (MRI), magnetic resonance angiography within 24–72 hours after the onset of symptoms and in dynamic during the period of maximum severity of symptoms. A chest radiograph was done if pulmonary disease or heart failure was suspected. Stroke was defined according to criteria of the World Health Organization, American Heart Association/American Stroke Association guidelines for adult stroke and was confirmed by neuroimaging [23, 24]. The etiology of stroke was classified according to the TOAST (Trial of Org 10172 in Acute Stroke Treatment) criteria [25]. The National Institutes of Health Stroke Scale, modified Rankin scale, and the Barthel index were determined in all participants. Secondary stroke prevention was prescribed according to the American Heart Association/American Stroke Association and the European Stroke Organisation guidelines, immediately after the stroke diagnosis was made [26–32]. Stroke education programs on recurrence prevention behaviors among stroke patients were provided to all study participants [13, 33–35].

Parametric and non-parametric univariate comparisons were performed with $\chi^2$, Fisher exact, Mann-Whitney U, and Student’s $t$-tests, as appropriate. The log-rank test was used for univariate comparisons of event-free survival between groups. A two-sided $p < 0.05$ was considered significant for all analyses. All statistical analyses were performed using IBM SPSS Statistics Version 22 (IBM, Armonk, NY).

Results and discussion

In total, 124 patients aged 28 to 84 years old with acute ischemic stroke were screened. The localization of primary stroke lesion confirmed by the neuroimaging was as follows: cerebral hemispheres ($n = 68$), brainstem ($n = 11$), cerebellum ($n = 45$).

Among the 124 patients, 42 (22 men and 20 women) were diagnosed with the remote diaschisis. These 42 patients had a mean age of $60.8 \pm 12.5$ years (from 32 to 84 years). Primary brain lesions in the study group were localized: in brain hemisphere ($n = 31$), pons Varolii ($n = 5$), cerebellar hemisphere ($n = 6$).

Based on the localization of the primary brain lesion and considering secondary dysfunction of brain neighboring structures, we have analyzed and described clinical manifestations and characteristics of the following forms of distant diaschisis: crossed cerebellar diaschisis ($n = 5$), crossed ce-
rebellar hemispheric diaschisis \((n=6)\), and ponto-cerebellar diaschisis \((n=5)\). Clinical features of crossed cerebellar diaschisis were analyzed in detail in our previous publications \([18, 22]\). This article analyzes clinical manifestations and course of crossed cerebellar hemispheric diaschisis.

The crossed cerebellar hemispheric diaschisis was diagnosed in 6 \((4.8\%)\) of 124 screened acute stroke patients. Contralateral cortical focus of ischemia was detected in these six patients with unilateral cerebellar infarction. Acute isolated cerebellar infarcts were caused by embolism from the heart or atherosclerotic occlusion of one of the branches of the superior cerebellar artery or posterior inferior cerebellar artery and were combined with ischemic damage (diaschisis) of the parietal cortex of the contralateral hemisphere of the brain (Fig. 1).

In such a situation, the neurological deficit in the unilateral cerebral infarction was characterized not only by the symptoms of cerebellar dysfunction (dizziness, limb ataxia, intention tremor, imbalance, lateropulsion, dysarthria, nystagmus), but also by motor and sensitive deficits on the side of the primary lesion in the cerebellar stroke \([18, 22]\).

In a published in 2010 study \([36]\), based on a survey of 24 patients with cerebellar infarction using positron emission tomography, CT, and MRI, 95.8 \% of patients had hypometabolic disorders in the cortex of the contralateral hemisphere of the brain; structural and morphological changes in the brain tissue according to CT and MRI data were not revealed. Concurrently, the author notes that cerebellar infarction manifested itself not only in cerebellar deficiency, but also in sensitivity disorders and limb paresis.

In our opinion, such conduction neurological disorders could be determined not only by metabolic, but also by morphological changes in brain tissue. After all, even after the transitory ischemic attack with complete regression of the neurologic deficit, approximately half of the examined patients have brain infarction according to diffusion-weighted MRI \([37]\). Crossed cerebellar hemispheric diaschisis after acute cerebellar infarction is often accompanied not only by circulatory metabolic problems, but also by structural and morphological disorders of neurons and white matter of the contralateral hemisphere of the brain \([38]\).

The main mechanism of crossed cerebellar hemispheric diaschisis is considered to be an interruption of efferent impulses at the cerebellar dentate or dentate-thalamo-cortical pathway to the Wernicke cross in the superior cerebellar peduncle (Fig. 2).

Consequently, isolated cerebellar infarctions can manifested not only in ataxic disorders, but also in motor and sensory impairments due to the damage of the frontal parietal cortex (diaschisis) of the opposite hemisphere of the brain. The neurological deficit in patients with a focal cerebellar lesion that has developed after an isolated infarction (hematoma) does not always correspond to the anatomical localization of the lesion. This leads to the violation of the well-known in neurology Holmes’ rule: “the relationship between the focus of cerebellar lesion and cerebellar deficiency in humans and animals” \([39]\).

Conclusions

Isolated cerebellar infarctions often cause crossed cerebellar hemispheric diaschisis in the contralateral cortex of frontal or frontal parietal lobe of the brain accompanied by structural and morphological findings on MRI in 87.5 \% of observations. Neurologists should know that cerebellar stroke can manifest not only in typical symptoms of cerebellar dysfunction (dizziness, static and coordination disorders, dysmetria, intentional tremor, nystagmus, dysarthria), but also in the remote symptoms such as limb paresis, impaired sensitivity and mental functions caused by crossed hemispheric diaschisis.

Conflicts of interests. Authors declare no conflicts of interests that might be construed to influence the results or interpretation of their manuscript.

Author contributions: S.M. Vinyuchuk — study concept and design, interpretation of data, data acquisition; O.Ye. Fartushna — article concept and design, literature overview, data acquisition, interpretation of data, and drafting the article.

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Слуховий аналіз випадків перекрестного мозочково-півкульного діашизу в пацієнтів із гострим інсультом

Резюме. Актуальность. Ишемия мозга является второй по частоте причиной смертности у взрослых в развитых странах. Подобное явление отмечается не только при очаговых поражениях головного мозга, но и при наличии дополнительных ишемических изменений в других его областях, которые не связаны с очагами поражения.

Мета дослідження. Визначення особливостей клинічних проявів перекрестного мозочково-півкульного діашизу у пацієнтів з ішемічним інсультом.

Матеріали та методи. Проведено проспективное госпитальное когортное исследование 124 пациентов с острым ишемическим инсультом, которые прошли комплексное клинико-неврологическое, лабораторное, ультразвуковое и нейровизуализационное обследование.

Висновки. Основным механизмом возникновения перекрестного мозочково-півкульного діашизу в пацієнтів із гострим ішемічним інсультом.

Ключеві слова: перекрестный мозочково-півкульный діашиз; інсульт мозочка; мозочок; дистантный діашиз; форми діашизу; клінічні прояви; діагностика; клінічний випадок