Neuroimaging And Neuropsychological Studies in The Clinic Of Mild To Moderate Brain Injury

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ABSTRACT

Mild to moderate traumatic brain injury (CBI) dominates the overall neurotrauma structure (80-90%). Despite a relatively good prognosis for mental recovery, in these cases, about 10-15% (according to some data, up to 30%) of patients with mild and about 50% of patients with moderate degrees of CHT develop chronic (persisting for several years after the injury) cognitive deficits.

Keywords: neuropsychology, cognitive function, brain injury, neuroimaging techniques, psychopharmacotherapy, neurorehabilitation.

Introduction. However, the quality of a patient's life and social adaptation depend to a great extent on the preservation of cognitive functions. Therefore, the role of the neuropsychologist in assessing the severity, structure of the defect, and dynamics of cognitive recovery (primarily controlling functions, memory, and speech) for post-rehabilitation is extremely important. Other critical tasks of the neuropsychologist in the acute trauma clinic include participation in brain organization studies to assist in planning surgical interventions and determining prognosis for recovery, and monitoring the effects of pharmacotherapy and neurosurgery. These tasks have both practical and theoretical aspects

Application of neuroimaging techniques and conducting neuropsychological research on brain injury

The peculiarities of pathology in brain injury determine the specificity of research in this area. Thus, character physical (contact and inertial, causing respectively predominantly local and diffuse pathology) impact at the time of injury, as well as a cascade of reactive neurophysiological changes after injury, determine the presence of not only local, but also cerebral disorders in patients. Since the symptomatology of cerebral abnormalities is an integral part of the symptom complex in CMT, the study of symptoms of local (focal) cerebral pathology and specific hemispheric syndromes in patients with CMT requires special approaches.

Focal cortical and subcortical contusions and diffuse axonal damage (DAD) are the most common types of primary brain injury. Focal contusions are most commonly caused by shock-impact mechanisms. DABs are caused by rotational, braking or acceleration mechanisms that stretch and damage axons. The semi vascular center, inner capsule, corpus callosum

and brain stem are the most vulnerable to this type of injury.

The anatomic features of certain brain regions (frontal regions, the corpus callosum, deep medial structures, including basal ganglia and anteroventral regions, as well as temporal regions and hippocampus) contribute to their particular vulnerability in traumatic brain injury. This accounts for the "nuclear" symptomatology present in the picture of almost any traumatic event (impaired control, attention, memory, neurodynamic and speech disorders). However, due to the individual combination of multiple factors (nature and severity of the trauma, patient's premorbid, genetic profile, etc.), it is difficult to define a single neuropsychological syndrome in brain injury. Moreover, almost any pattern of cognitive impairment can be found in this category of patients.

Accurately diagnose the degree of microstructural axonal damage at an early stage after injury by means of routine CT or MRI is difficult in most cases, since these studies are not always allowed you to visualize the violations that have arisen. Most researchers agree that diffusion-tensor imaging (DT-I) with MRT is quite informative. The diffusion-tensor MRT (DT-MRT) method allows assessment of diffusion characteristics of the medium under study and the direction of water diffusivity (anisotropy) and thus provides information on the degree of white matter tracts preservation. Diffusive anisotropy is heterogeneous in different white matter regions and reflects differences in myelination of fibers, their diameter and orientation. Fractional anisotropy (FA) characterizes the spatial orientation of fibers and denotes the extent of diffusion excess along one direction compared to the other and is used as a quantitative index of diffusion anisotropy degree. Pathological processes that change white matter microstructure, such as fiber rupture, disorganization, and separation, combined with myelin rupture, neuronal retraction, and an increase or decrease in extracellular space, affect diffusion and anisotropy indices.

FA and mean diffusivity (MD) are the most informative and most commonly used indices in a DT study. Water diffusivity provides important information for determining the mechanisms of change in white matter after myelin injury or axon loss. FA is decreased in most brain tracts after a traumatic brain injury. Thus, according to the data of long-term follow-up studies, there is a diffuse atrophy of the corpus callosum, the most vulnerable to traumatic effects.

The most promising current approach to investigating functional brain changes in traumatic brain injury (TBI) by recording brain activity (using φMRT) during cognitive tasks requires taking into account a number of emerging problems. For example, head movements during φMRT recording may coincide with the expected cerebral response to a stimulus and be falsely interpreted as brain activation corresponding to the activity under investigation.

In φMRT studies, when applying the activation analysis of the researcher's predetermined "regions of interest", it should be kept in mind that cognitive activity is carried out with the participation of a functional system of coordinated multiple brain regions, rather than a single brain region chosen by the researcher. Pathway analysis of brain activation (partial least squares) allows determining the degree and direction of interconnection between brain structures and assessing the functioning of brain networks . In this situation, the ideas developed in neuropsychology about the systemic structure of higher mental functions and their connection to the functioning of certain brain sections are of great importance.

The choice of experimental design for fMRT studies depends on the nature of the research task. If a detailed analysis of cognitive processes is required, the most suitable paradigm is the event-related response (it allows you to highlight individual patterns of short-term brain activation in response to single stimuli from the general hemodynamic response), which has a high spatial and temporal resolution, which allows recording episodes of brief activation and comparing it with the quality of the performance of activities, as well as to record the activation of

areas included in one functional system. Block design, which allows obtaining a measure of averaged brain activation during task performance over a certain time interval, has become widespread due to its simplicity and brevity].

To improve the reliability of φMRT data, additional factors affecting cerebral activation should be considered. For example, it is known that an increase in cognitive load can change both the degree and the localization of cerebral activation. For example, increasing the amount of same-type work memory load in healthy subjects increases right hemispheric activation, whereas under normal conditions performance of a work memory test is associated with left-lateral activation. In patients with a traumatic brain injury the activation pattern is similar to the norm due to the increased activation . When investigating the dynamics of recovery after trauma, it is important to consider that the novelty of a stimulus affects the degree and localization of brain activation (the more familiar the stimulus, the less activation it causes) . The subject's emotional state also affects the features of brain activation. Indeed, structures such as the amygdala, anterior singular cortex, and frontal regions are involved in both cognitive and emotional processes.

Due to the high variability of brain activation patterns during cognitive activity in normal and even more so in patients with TBI, random effects analysis (random effects analysis) is more informative when analyzing φMRT data, allowing for a picture of the most frequent activation foci in the studied patient group instead of an "averaged" activation pattern using fixed effect analysis .

Various factors influence the correct assessment of activation in neuroimaging studies. For example, the heterogeneity of the abnormalities and the appearance of some of them only over time, as well as the variation in time from the trauma to the examination, have an impact on the results. (due to its high resolution, relative accessibility and lack of radiation exposure), is insufficiently sensitive in certain situations, and is susceptible to artifacts when imaging the ventral frontal and temporal regions.

Early φMRT and positron emulsion tomography (PET) studies used stimuli organized in clusters. More recent φMRT technologies allow the use of an event-related design, where individual samples are not clustered and can be presented and analyzed one at a time. Cluster interlocked design provides good signal sensitivity and is indispensable in the study of cognitive processes that have its temporal dynamics (for example, the process of maintaining attention for a certain period of time). However, event-related design is preferable because it avoids the negative effects of grouping multiple samples into a single block.

Proper research design requires a comparison of the brain activation patterns of the experimental task with those of the control task. The latter should be identical to the experimental task in all respects, except for the parameters of interest to the researcher. Such conditions are extremely difficult to achieve in φMRT studies. For example, tasks that require deactivation are often used as controls (e.g., visual fixation, which is itself a special activity that produces a specific pattern of activation of brain structures). When examining patients with altered brain activation patterns who have difficulty performing test tasks, it is difficult to determine whether the changes in brain activation patterns are due to trauma or to variations in the experimental task.

It is known that achieving the same result when performing the same task, it can normally be achieved with the involvement of various brain functional systems whose components can be activated simultaneously, making it difficult to determine which brain regions belong to which functional system.

The quality of task performance should be comparable to that of the control group. The quality of task performance in patients should be comparable with that in the control group. Activation of homonymous areas in the normal and sick patients suggests that these areas are involved in performing a given task and are probably the necessary links for its performance. Areas that are activated in healthy controls but not in patients are most

likely not necessary for performing the task or belong to an alternate functional system. Brain areas that are only activated in sick people are likely to be untrained or inhibited in healthy people.

Post-traumatic white matter injury is known to be associated with cognitive impairment. For example, in a study by R. Kumar et al. in 38 patients with a moderate degree of trauma (Glasgow scale score – GSS of in the acute period, according to MRT data, there was a decrease in FA in the anterior and posterior femur of the internal capsule and in the knee of the cerebellar body. Six months after injury, along with the already identified abnormalities, a decrease in FA in the anterior and patellar regions of the internal capsule, as well as in the anterior and posterior regions of the internal capsule was detected in all patients with hemorrhagic type of DAP. These changes may indicate an ongoing process of demyelination and gliosis. Identified in long-term period after the injury of the disorder (even if they were insignificant and local) positively correlated with visual attention disorders, the ability to switch and the speed of psychomotor activity, as well as the performance of spatial tasks. The presence of hemorrhages and/or visible signs of DAP in the acute period after trauma do not correlate with the severity of cognitive impairment 6 months after injury. The presence of DAP hemorrhages and/or visible DAP signs in the acute period after injury did not correlate with the severity of cognitive impairment 6 months after injury.

DT-MRE is one of the most sensitive methods of diagnosing white matter lesions, and repeated follow-up studies have great prognostic value in determining the non-horological outcome of trauma. S. Naganawa et al.reported the use of DT-I in a follow-up study of a 27-year-old woman with severe closed trauma from an automobile accident. A CT scan performed on the day of the accident showed small hematomas in the right temporal and parietal region and a small hemorrhagic focus in the right lateral ventricle. A DT-I was performed 3 times: on day 4 after the trauma (GSS-6), when bilateral intraventricular hemorrhages, a cerebral body lesion and a hematoma in the right parietal region were detected. A follow-up examination was carried out 24 days after the injury, when the patient's status had improved slightly (GSS-11). This examination showed an increase (compared to the previous examination) in the ventricles, a more extensive lesion of the corpus callosum, including the anterior regions, and fibers in the frontoparietal regions. The third study was performed 2 months after injury, when there were no significant changes in the patient's status (GSS-11) and according to DT-I studies.

A common consequence of DAP is cerebral atrophy, which begins approximately 3 weeks after moderate to severe trauma and reaches a significant level after 8-12 months. Cerebral volume loss continues up to 3 years after injury, at a rate faster than normal aging. The severity of posttraumatic atrophy is proportional to the severity of injury and correlates with the GSS score on admission, coma duration, and posttraumatic amnesia. A similar pattern is observed in mild trauma.

The use of the most sensitive diagnostic methods and the ability to investigate the full spectrum of brain injury severity allowed D. Rutgers et al.in a prospective study of 39 patients (24 with mild, 9 with moderate and 6 with severe TBI) in the first 3 months after trauma using T1, FLAIR, T2 weighted gradient-echo and DT-I sequences showed a reversible decrease in FA and increased diffusivity coefficient (DC) in the cerebellar knee in patients with mild trauma, and a different pattern of impairment in patients with moderate and severe trauma (decreased FA and increased DC in the knee and decreased FA without change in the DC of the cerebellar body roll). Reduced FA is usually associated with parenchymal structural changes such as displacement and fiber damage or oedema. Such abnormalities are reported to be more reversible in the anterior (knee) than in the posterior (roll) sections of the corpus callosum. The presence of inconsistencies with the findings may be due to differences in the organization of the studies. Thus, in one of the studies in patients with mild trauma, examined on average 4 and 68 days after injury, pathology with side of the knee of the corpus

callosum was not observed, and in the fold, there was a decrease in FA and an increase in BP. In another study, the FA was decreased in the knee and the roll 24 hours after injury. In another study, patients with mild trauma had reduced FA in the knee and roll 24 h after injury. In severely injured patients studied at 14 months post-injury, FA was decreased in the knee, body and roll of the corpus callosum. In a study examining patients with varying severity of injury, 7 days after injury, changes were noted in the knee and the roll of the corpus callosum. There was also a decrease in KD, which indicated the presence of cytotoxic edema.

Cyclic fluctuations of cerebral blood flow in normal conditions demonstrate synchronous functioning in the two hemispheres (in structures such as motor and visual cortex, as well as thalamus and hippocampus). Such synchrony is evidence of preserved interhemispheric connectivity provided by the structures of the corpus callosum. In a study by M. Quigley et al. showed with an φMRT study that agenesis of the corpus callosum leads to decreased interposition connectivity (the number of ipsilateral connections prevailed over contralateral ones) in the motor area and the auditory analyzer representation area.

The use of DT-I enabled Holodny et al.more accurately verify the anatomical organization of the corticospinal tract (CST) in the area of its passage through the posterior femoral internal capsule (PFIC). In order to localize motor zones, 8 healthy volunteers and 2 patients with tumors at the site of the CST passage through the PFIC were asked to perform a series of taps (so-called tapping test) alternately with the left and right hand/foot. In 17 of the 20 cases, the CST fibers passing through the PFIC were somatotopic, with the fibers innervating the arms laterally and slightly in front of the fibers innervating the legs. In the remaining three cases, the fibers innervating the arms and legs were displaced.

N.E. Zakharova et al. [8] using MRT in T1, T2, T2- FLAIR and diffusion modes in 22 patients with DAP due to severe TBI (4-8 points GSS at the time of hospitalization) have shown that in the first 2-17 days after the injury, accompanied by coma and varying degrees of disability in the follow-up, there are extensive changes in the structure of cerebellar body and CST pathways. The most sensitive indicator of conduction pathway damage during DAP in the early post-injury period was FA values. Significant decrease in these parameters as compared to the norm was detected in both the structures of the corpus callosum and CST at different levels in all the victims. For a more detailed analysis of the data obtained, three subgroups of patients were identified: without obvious signs of pyramidal insufficiency, with the presence of unilateral hemiparesis of varying degrees, and with the presence of tetraparesis. A characteristic feature of the first subgroup with the most favorable outcome of DAP was a significant decrease in FA values in all the studied structures, but without a clear asymmetry of values at similar levels of CST. In the same time in patients of the second subgroup with clear clinical signs of unilateral pyramidal symptoms, FA values at the contralateral hemiparesis side were significantly lower than in the control. In addition, FA values along the CST pathway differed significantly on the homo- and contralateral hemiparesis sides also at the level of PFIC and brain stem. The lowest FA values on both sides at all levels of CST and MDC at the bridge level were obtained in patients with tetraparesis and outcomes in profound disability or vegetative state. These findings indicate that FA reliably reflects CST damage in traumatic brain injury. The observed significant correlation between the outcome of DAP and FA values in the cerebral body and the pathway of the CST obtained on days 2-17 after injury indicates the high prognostic significance of diffusion anisotropy. It can be assumed that primary damage to the conduction pathways (in the structures of the CST and the corpus callosum) during DAP leads to axonal degeneration, causing a more significant decrease in anisotropy from 2-3 weeks after injury. Severe diffuse brain damage is a trigger for degenerative changes in axons and myelin sheaths of the white matter of the brain, leading to their complete destruction and atrophy 2-3 months after injury.

A study of healthy volunteers showed that the mean measured diffusion coefficient (MDC) and FA were not significantly different at the symmetrical levels of the two cortico-spinal tracts. However, the mean FA values along the CST pathway were significantly lower at the level of the pons than at the level of the cerebellar peduncle and the posterior femur of the internal capsule. These results confirm the morphological evidence of significantly higher fiber density of the CST at the level of the PFIC and brain peduncle than at the level of the bridge, where there are its intersections with the transverse fibers. Consequently, diffusion anisotropy values reliably reflect the degree of integration and unidirectionality of cerebral white matter conductive fibers, which should be considered in the study of various cerebral pathologies.

These studies suggest that neuropsychological methods are sufficiently sensitive to investigate the dynamics of cognitive impairment after a traumatic event. These studies allow us to describe the different nature of cognitive impairment at different stages of recovery - the presence of predominantly generalized symptoms in the initial stages of recovery and the formation of a more definite neuropsychological syndrome at later stages. A qualitative characterization of symptom dynamics is essential for the planning of rehabilitation measures.

Literature

1. Akramova D. et al. Stroke incidence and association with risk factors in women in Uzbekistan //Cerebrovascular Diseases. – Allschwilerstrasse 10, Ch-4009 Basel, Switzerland : Karger, 2017. – T. 43.
2. Bobomuratov T.A., Sharipova O.A., Akramova N.T. Assessing the impact of secondary prevention among boys with bronchiectasis and delayed pubertal development // Science and Innovations in the Globalized world. San Diego, 2016. Vol. 1. P. 114-119.
3. Khamdamov B.Z. Indicators of immunocitocine status in purulent-necrotic lesions of the lover extremities in patients with diabetes mellitus.//American Journal of Medicine and Medical Sciences, 2020 10(7) 473-478.
4. M. I. Kamalova, N.K.Khaidarov, Sh.E.Islamov,Pathomorphological Features of hemorrhagic brain strokes, Journal of Biomedicine and Practice 2020, Special issue, pp. 101-105
5. Kamalova Malika Ilkhomovna, Islamov Shavkat Eriyigitovich, Khaidarov Nodir Kadyrovich. Morphological Features Of Microvascular Tissue Of The Brain At Hemorrhagic Stroke. The American Journal of Medical Sciences and Pharmaceutical Research, 2020. 2(10), 53-59
6. Khodjieva D. T., Khaydarova D. K., Khaydarov N. K. Complex evaluation of clinical and instrumental data for justification of optive treatment activites in patients with resistant forms of epilepsy. American Journal of Research. USA. № 11-12, 2018. С.186-193.
7. Khodjieva D. T., Khaydarova D. K. Clinical and neuroph clinical and neurophysiological ch ogical characteristics of teristics of post-insular cognitive disorders and issues of therapy optimization. Central Asian Journal of Pediatrics. Dec.2019. P 82-86
8. Kasimov, Arslanbek; Abdullaeva, Nargiza; Djurabekova, Aziza; Shomurodova, Dilnoza//Features of diagnosis and clinic of post-traumatic epilepsy against the background of concomitant somatic diseases. International Journal of Pharmaceutical Research (09752366) . Jul-Sep2020, Vol. 12 Issue 3, p1788-1792. 5p.
9. Kasimov Arslanbek Atabaevich, Bozorova Sabohat Normo'min qizi, & Gulkhayo Eshmatovna Zhumanova. (2022). Results of a study of clinical and neurophysiological changes in patients with post-traumatic epilepsy with concomitant somatic diseases on the

basis of complex drug therapy. World bulletin of public health 10, 186-190

10. Kasimov Arslanbek Atabaevich. (2022). Dynamics of clinical and neurophysiological changes against the background of complex medical therapy in patients with posttraumatic epilepsy with concomitant somatic diseases. Frontline Medical Sciences and Pharmaceutical Journal, 2(03), 78–87.
11. Khudaynazarova Muattar Tokhirjonovna, Ruziyev Jononbek Elmurodovich, & Kasimov Arslanbek Atabayevich. (2022). Peculiarities of diagnosis and clinical picture of posttraumatic epilepsy against the background of concomitant somatic diseases. World bulletin of public health, 10, 121-126.
12. Uralov, F. S. ., Khurramov, M. B. ., Kasimov, A. A. ., & Mamurova, M. M. . (2022). Modern Methods of Epilepsy Treatment and Prevention of Tactical and Therapeutic Errors in Epilepsy Treatment. International Journal Of Health Systems And Medical Sciences, 1(4), 374–377.
13. Шомуродова Д. С., Джурабекова А. Т., Мамурова М. М. Особенности и прогноз поражения нервной системы у беременных женщин с преэклампсией характеризуемые методами функциональной диагностики //журнал неврологии и нейрохирургических исследований. – 2020. – Т. 1. – №. 2.
14. Мамурова, М., Рузиева, Ш., Олланова, Ш., Хакимова, С., & Джурабекова, А. (2015). Клинико-неврологические особенности Хронических цереброваскулярных заболеваний, обусловленных Артериальной гипертензией, у пациентов молодого возраста. Журнал вестник врача, 1(4), 39–42.
15. Мамурова М. М., Джурабекова А. Т., Игамова С. С. Оценка когнитивных вызванных потенциалов головного мозга (р-300) у лиц молодого возраста с артериальной гипотензией //журнал неврологии и нейрохирургических исследований. – 2021. – Т. 2. – №. 1.
16. Rakhmonova H.N., Rakhmonov Z.M. Innervation Relationships of the Gallbladder Nerve Apparatus with Spinal and Rheumatic Nerve Ganglia (Literature Review). Eurasian Medical Research Periodical, 18, 105-108.
17. 18 Рузиева, Ш., Мамурова, М., Хакимова, С., & Джурабекова, А. (2016). Клиническая характеристика больных с транзиторными ишемическими атаками. Журнал проблемы биологии и медицины, (2 (87), 79–82.