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# CEREBRAL CIRCULATION AND COGNITIVE FUNCTION IN CHRONIC MIGRAINE: STRATEGIES FOR TREATMENT IMPROVEMENT

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**Abstract.** This study investigated the therapeutic potential of transcranial magnetic stimulation (TMS) in the management of migraine. Migraine is a widespread neurological disorder, affecting approximately 12–15% of the global population, and is characterized by recurrent severe headache attacks. Due to the unclear pathogenesis of the disease, conventional treatments often fail to provide consistent results. In this study, repeated TMS therapy was applied to 14 patients (4 men, 10 women; mean age 38.8 ± 10.2 years) who had previously shown insufficient response to medication. Stimulation was performed using the "Dyo MAG XT" device over a 10-day period. Post-treatment analysis revealed a 33.4% reduction in the monthly frequency of migraine attacks, a 7.3% decrease in headache intensity, and a 34.7% reduction in depression scores. These results confirm that TMS is a safe and effective intervention, although further research is required to clarify its role in migraine prevention.
**Keywords:** migraine, aura, Transcranial Magnetic Stimulation, Hamilton Scale, MIDAS scale.

Migraine is characterized by headaches of severe intensity, a decrease in cognitive functions, a decrease in memory and attention, emotional lability and a decrease in the quality of life. Epidemiological analyzes show that chronic migraine is on the rise among the younger generation. This condition seriously affects labor productivity and social activity. According to the World Health Organization (WHO), chronic headaches and migraines affect approximately 14–15% of the world's population and are among the leading neurological causes of disability. The chronic form of migraine is often noted among the elderly and active population, which causes great economic and social damage to the society. Changes in cerebral hemodynamics in patients with chronic migraine have been widely studied, but opinions vary. Despite the fact that migraine has been studied for a long time, there is no single opinion on its etiology and pathogenesis. Existing pathogenetic and symptomatic methods of migraine treatment do not allow to reduce the number of attacks, and sometimes do not have a therapeutic effect at all. The therapy used to prevent recurrent migraine attacks does not always give the expected effect. This indicates the urgency of searching for additional methods of diagnosis and treatment of migraine.

Transcranial Magnetic Stimulation (TMS) is a relatively new method in medicine, through which it is possible to influence the human nervous system. The essence of the TMS method is the stimulation of nerve tissue using an alternating magnetic field. It is able to suppress or activate different parts of the cerebral cortex, and is based on the law discovered by Faraday in 1831: "in a conductor near a changing magnetic field, an electric current is induced, in which the strength of the current is directly proportional to the frequency of changes in the magnetic field."

**The purpose of the study:** to evaluate the therapeutic effectiveness of repeated transcranial magnetic stimulation in the treatment of migraine.

**Materials and methods:** Repetitive transcranial magnetic stimulation (TMS) was performed on 40 patients with migraine who had failed medical treatment. 12 of them were men, 28 were women, and their average age was 38.8 ± 10.2 years.

The study was conducted at the medical-diagnostic center "Faily-Med" in Andijan. All patients underwent additional paraclinical examinations in order to exclude pathological brain changes. Patients complained of headache, which was classified as "migraine without aura"

(simple migraine) according to the second edition of the International Classification of Headache Disorders. The MIDAS (Migraine Disability Assessment) scale was used to assess the severity of migraine, the visual analog scale (VASh) was used to assess the intensity of headache, and the Hamilton scale was used to assess the level of depression.

Stimulation was carried out using the Dyo MAG XT device manufactured by Brainbox. The device is equipped with a "butterfly" type inductor with a maximum inductance of 2 Tesla and a frequency of 60 Hz. All patients received TMS to the dorsolateral prefrontal cortex (DLPFK) region at a frequency of 5 Hz, at an intensity of 120% of the motor threshold, for 10 minutes. The course of treatment consisted of 10 sessions, which were carried out at the same time every day.

**Results**. The reason for patients to seek help was the ineffectiveness of long-term treatment with drugs, due to which the drug was discontinued. These patients voluntarily abstained from drug treatment in which they used nonsteroidal anti-inflammatory drugs (acetylsalicylic acid, ibuprofen, metamizole sodium), triptans, selective serotonin reuptake inhibitors (SSRIs), and combination drugs, but had not used any drugs for more than 3 months before TMS application. Patients say that the reason for abandoning drugs was their low effectiveness or no effectiveness at all.

It is known that the criteria for evaluating the effectiveness of migraine treatment are a decrease in the frequency of attacks and an increase in the time between attacks. These concepts are somewhat interrelated - if the remission time between attacks is extended, the number of attacks per month will decrease. However, we can talk about the time between attacks only conditionally, because their occurrence does not occur at equal intervals, but can be triggered by factors such as psycho-emotional conditions, consumption of certain drugs or food products. Therefore, we considered the average number of seizures per month prior to treatment, and patients experienced an average of 4.4 seizures per month prior to TMS therapy. After the course of TMS, this indicator fell to 3 on average. In two patients, the frequency of attacks did not change.

Before the start of treatment on the MIDAS scale, level III (18, 18 and 16 points) was determined in 3 patients, which means severe pain and significant limitation of daily activities. In the remaining 7 patients, grade IV was confirmed, which is also characterized by severe pain and a sharp decrease in daily activities.

The main purpose of the MIDAS scale is to assess the impact of migraine on daily activities and to determine the degree of impairment of flexibility. We analyzed the results according to the MIDAS scale and calculated the mean values before and after treatment for all patients. The obtained results showed an improvement in daily activities, a decrease in the number of days with reduced work capacity and activity. After the course of TMS, the degree of flexibility impairment of the patients changed. The number of days with reduced work capacity and daily activities decreased in all patients. At the same time, in 7 patients (2 more than before the TMS course) level III (18, 12, 19, 12 and 15 points) was determined, which indicated severe pain and significant limitation of daily activities. In the remaining 5 patients, level IV remained after the course of TMS, which still means severe pain and a sharp decrease in daily activities.

The intensity of headache according to the visual analog scale (VASh) decreased in 5 patients, 4 of them had a decrease of 1 point, and 1 of them had a decrease of 2 points. The number of monthly attacks decreased to an average of 3, and these results were observed for 3 months after the course of TMS.

It is known that migraine is often accompanied by depressive disorders. These two pathological conditions are directly related to each other: migraine creates favorable conditions for the development of depressive disorders, in turn, depression aggravates migraine symptoms.

As mentioned above, we used the Hamilton scale to assess depression. This scale reflects the patient's condition during the last week. We interviewed our patients before the start of the TMS course and one week after the end of the course. The results showed that the mood of the patients improved, the level of depression decreased and other symptoms of depressive disorders decreased.

Thus, the severity of depressive symptoms according to the Hamilton scale decreased by 34.7%, and the level of impairment of daily activities according to the MIDAS scale improved by 25.6%. The number of monthly attacks decreased by 33.4%, and the intensity of headaches decreased by only 7.3%.

Along with a decrease in the frequency of attacks, it is natural to increase the ability to work and general activity. However, although all patients showed improvement on the MIDAS scale, the frequency of attacks did not decrease equally in all patients. We also attribute this result to a reduction in depressive symptoms, as mood has a direct effect on activity level. In addition, the 2 patients who did not change the frequency of attacks and the intensity of headaches also noted an improvement in their general condition.

From the neurophysiological point of view, this effect is explained by the increase of neuronal activity in the dorsal prefrontal cortex and the strengthening of functional connections with limbic structures. Under the influence of TMS pulses, the efficiency of synaptic transmission increases and neuroplastic changes are activated. As a result of these processes, activity in the systems of attention, information processing and short-term memory is stabilized.

Clinically, patients have seen recovery of work capacity, improvement in the ability to maintain long-term attention in studies or professional activities. In some cases, positive changes were noted in the speed of personal reasoning and decision-making processes, as well as in personal emotional stability. Optimum activation of circulation and neurotransmitter systems by TMS probably alleviated the cognitive "inhibition" associated with migraine.

t the same time, a negative correlation was noted between the results of cognitive tests and hemodynamic indicators (in particular, PI and MCA speed), which confirms that the stabilization of blood circulation is inextricably linked with the functional state of brain activity. Cerebral blood circulation status after TMS was evaluated by UTD method in patients with chronic migraine. Internal carotid artery (ICA), middle cerebral artery (MCA), vertebral artery (VA) and vertebral artery (PCA) and pulsatility index (PI) were measured during the study. After TMS, blood flow velocity was significantly increased in all major arteries. Especially in ICA (InternalCarotidArtery) and VA (VertebralArtery) increase of blood flow rate was noted at a high level ($t=12.9$ and $t=15.5$, $p<0.05$). These changes are explained by the normalization of the tone of the vessel walls and the improvement of blood supply to the brain parenchyma as a result of the TMS effect. Increases in MCA (MiddleCerebralArtery) and PCA (PosteriorCerebralArtery) blood flow velocities were also statistically significant, suggesting that TMS also affects central parts of the neurovascular system. This condition is probably associated with increased synaptic activity and restoration of the automatic autoregulatory system.

At the same time, changes in PI (PulsatilityIndex) indicator are not significant ($t=0.59$, $p>0.05$). This situation indicates that vascular stability is preserved in the period after TMS, that is, hemodynamic resistance does not change dramatically. TMS therapy improves the efficiency of blood circulation in the main arteries of the brain in patients with chronic migraine. An increase in blood flow velocity in the ICA, MCA, VA, and PCA is associated with improved blood supply and restoration of vascular tone, confirming the importance of this method in providing hemodynamic stabilization. The significant invariance of the PI indicator indicates that the adaptive capacity of the blood vessels is preserved and that TMS does not impose a load beyond the physiological norm.

Changes in psychoemotional status in patients after TMS treatments were assessed using the HADS. After TMS, the average anxiety score (HADS A) was 6.62±0.19 points, and the depression score (HADS D) was 5.91±0.22 points. These results show a dramatic reduction in mild anxiety and depression compared to pre-TMS (HADS A≈10.8points and HADS D≈9.7points before TMS).

Side effects. According to the scientific literature, various side effects have been reported during the period when TMS was used as a method of diagnosis and treatment of neurological diseases [10]. The most common side effects include increased headache, dizziness, and itching at the site of stimulation. The most dangerous complication is a seizure induced by magnetic stimulation. However, no side effects were observed after TMS in our 14 patients.

**Conclusions:** Repetitive transcranial magnetic stimulation (TMS) is a safe and effective method that reduces the frequency of migraine attacks by 33.4%, improves mood and reduces depression by 34.7%. It also helps reduce daily activity decline by 25.6% and headache intensity by 7.3%. However, further study of TMS as a preventive treatment for migraine is warranted.

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