

**EVALUATION OF THE EFFECTIVENESS OF TRANSCRANIAL MAGNETIC  
STIMULATION IN DIFFERENT CLINICAL FORMS OF CEREBRAL PALSY IN  
CHILDREN**

*Sobirova Tursunoy Qodirjon qizi*

*Bustanov Oybek Yakubovich*

*Master's Student, Andijan State Medical Institute, Andijan, Uzbekistan*

*Scientific Supervisor, PhD, Associate Professor, Andijan State*

*Medical Institute, Andijan, Uzbekistan*

**Abstract**

Cerebral palsy (CP) is a group of non-progressive neurodevelopmental disorders characterized by persistent motor impairments resulting from early brain damage. Motor dysfunction remains the main factor limiting functional independence and quality of life in affected children. In recent years, transcranial magnetic stimulation (TMS) has attracted increasing attention as a non-invasive neuromodulation technique aimed at enhancing neuroplasticity and improving motor outcomes. This article evaluates the effectiveness of transcranial magnetic stimulation in children with different clinical forms of cerebral palsy. The analysis focuses on changes in motor function, muscle tone, coordination, and functional activity. The findings suggest that TMS, when integrated into comprehensive rehabilitation programs, contributes to significant functional improvement, particularly in spastic forms of cerebral palsy.

**Keywords**

Cerebral palsy, children, transcranial magnetic stimulation, neurorehabilitation, spasticity, motor function, neuroplasticity

**Introduction**

Cerebral palsy is the most common cause of chronic motor disability in childhood, with a prevalence of approximately 2–3 per 1,000 live births worldwide. The condition encompasses a spectrum of clinical forms, including spastic diplegia, hemiplegia, quadriplegia, dyskinetic, and mixed types. Although cerebral palsy is non-progressive, motor impairments often worsen over time due to secondary musculoskeletal complications and limited neuroplastic adaptation.

Traditional rehabilitation strategies, such as physiotherapy, occupational therapy, and pharmacological management of spasticity, remain essential components of treatment. However, these approaches often provide limited functional recovery. Advances in neuroscience have led to the development of neuromodulation techniques that directly influence cortical excitability and promote adaptive neuroplastic changes. Transcranial magnetic stimulation is a non-invasive method capable of modulating motor cortex activity and enhancing motor learning.

The aim of this study is to evaluate the effectiveness of transcranial magnetic stimulation in improving motor function across different clinical forms of cerebral palsy in children.

## Literature Review

Cerebral palsy (CP) is the most common cause of chronic motor disability in childhood and remains a major focus of pediatric neurorehabilitation research. Traditionally, rehabilitation strategies for CP have relied on physiotherapy, occupational therapy, and pharmacological management of spasticity. However, these approaches often provide limited improvement in motor function, prompting interest in novel neuromodulation techniques that directly influence brain plasticity.

Transcranial magnetic stimulation (TMS) has emerged as a promising non-invasive method for modulating cortical excitability and promoting functional reorganization of motor networks. Early studies in adult stroke populations demonstrated that repetitive TMS could enhance motor recovery by restoring interhemispheric balance and facilitating synaptic plasticity. These findings provided a theoretical foundation for the application of TMS in pediatric populations with non-progressive brain lesions, including cerebral palsy.

Several studies have investigated the safety and feasibility of TMS in children with CP. Valle et al. reported that low-frequency and high-frequency TMS protocols were well tolerated and did not produce serious adverse effects. Subsequent research confirmed the safety of repeated stimulation sessions in pediatric patients, emphasizing the importance of age-appropriate protocols and careful monitoring.

Clinical studies evaluating the effectiveness of TMS in cerebral palsy have primarily focused on spastic forms of the disorder. Kirton and colleagues demonstrated that TMS applied to the motor cortex of the affected hemisphere improved upper-limb motor function in children with hemiplegic CP. Improvements were attributed to enhanced cortical excitability and improved motor pathway integration. These findings support the concept that neuromodulation can augment traditional rehabilitation by enhancing motor learning.

Research on diplegic and quadriplegic forms of CP has also reported beneficial effects of TMS, although outcomes are more variable. Some studies indicate improvements in gait parameters, postural control, and muscle tone, particularly when TMS is combined with intensive physiotherapy. This suggests that the therapeutic effect of TMS is strongly influenced by the integration of neuromodulation with task-specific motor training.

The literature further emphasizes the role of neuroplasticity in mediating the effects of TMS. Repetitive stimulation induces long-term potentiation-like and long-term depression-like changes in synaptic transmission, which may facilitate reorganization of motor networks. In children, whose brains exhibit heightened plasticity, these effects may be particularly pronounced, offering a unique opportunity for functional improvement.

Despite encouraging results, the literature highlights several limitations. Variability in stimulation parameters, session duration, outcome measures, and patient selection complicates comparison across studies. Additionally, long-term follow-up data remain limited, and the durability of TMS-induced improvements requires further investigation.

In summary, existing literature supports the potential effectiveness of transcranial magnetic stimulation as an adjunctive therapy in the rehabilitation of children with cerebral palsy. Evidence suggests that TMS can enhance motor outcomes, particularly in spastic clinical forms, when integrated into comprehensive, individualized rehabilitation programs. Future research

should focus on standardizing protocols, identifying predictors of response, and evaluating long-term functional outcomes.

### **Materials and Methods**

This study was conducted as a narrative analytical review of scientific literature. Peer-reviewed clinical trials, systematic reviews, and meta-analyses addressing the use of transcranial magnetic stimulation in pediatric cerebral palsy were analyzed. Data were collected from international medical databases specializing in pediatric neurology and rehabilitation.

The analysis focused on clinical outcomes related to motor performance, muscle tone, coordination, and functional independence. Both low-frequency and high-frequency TMS protocols targeting motor cortical areas were considered. The effects of TMS applied alone and in combination with conventional rehabilitation methods were evaluated. No original experimental or clinical interventions were performed.

### **Results and Discussion**

The reviewed studies indicate that transcranial magnetic stimulation has a positive effect on motor function in children with cerebral palsy, particularly when used as an adjunct to standard rehabilitation programs. In spastic forms of CP, TMS has been shown to reduce muscle tone and improve voluntary motor control. These effects are attributed to modulation of cortical excitability and restoration of interhemispheric balance.

Children with hemiplegic cerebral palsy demonstrate improvements in upper-limb function, fine motor skills, and coordination following TMS therapy. Improvements are more pronounced when stimulation is applied to the affected motor cortex and combined with task-specific motor training. In diplegic and quadriplegic forms, TMS contributes to enhanced postural control and gait parameters, although the magnitude of improvement varies among individuals.

The therapeutic effects of TMS are closely linked to neuroplastic mechanisms. Repeated stimulation sessions facilitate synaptic reorganization and strengthen motor pathways involved in movement execution. Importantly, TMS has been shown to be a safe and well-tolerated procedure in pediatric populations, with minimal and transient side effects.

Despite promising results, variability in stimulation protocols, patient selection, and outcome measures limits direct comparison across studies. Further research is needed to establish standardized TMS protocols tailored to specific clinical forms of cerebral palsy.

### **Conclusion**

In conclusion, transcranial magnetic stimulation represents a promising and effective adjunctive therapy for improving motor function in children with cerebral palsy. Its effectiveness is most evident when applied as part of an individualized, multidisciplinary rehabilitation program. TMS contributes to reductions in spasticity, improvements in motor control, and enhanced functional performance across different clinical forms of cerebral palsy.

Future studies should focus on optimizing stimulation parameters, identifying patient-specific predictors of response, and evaluating long-term outcomes. Integration of transcranial magnetic stimulation into comprehensive neurorehabilitation programs may significantly enhance functional independence and quality of life in children with cerebral palsy.

### References

1. Rossini, P. M., et al. (2015). Non-invasive brain stimulation in neurological disorders. *Clinical Neurophysiology*, 126(6), 1071–1107.
2. Valle, A. C., et al. (2007). Transcranial magnetic stimulation in children with cerebral palsy. *Journal of Child Neurology*, 22(2), 197–202.
3. Kirton, A. (2013). Modeling developmental plasticity after perinatal stroke. *Developmental Medicine & Child Neurology*, 55(3), 18–25.
4. Fregni, F., & Pascual-Leone, A. (2007). Noninvasive brain stimulation in neurology. *Nature Clinical Practice Neurology*, 3(7), 383–393.
5. Novak, I., et al. (2013). A systematic review of interventions for children with cerebral palsy. *Developmental Medicine & Child Neurology*, 55(10), 885–910.