

Transcranial Magnetic Stimulation for Substance Use Disorders

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Background: Substance use disorders (SUDs) are a critical public health challenge, characterized by high relapse rates and limited efficacy of current treatment modalities. Advances in neuromodulation, particularly transcranial magnetic stimulation (TMS), offer promising therapeutic alternatives.

Objective: This review aims to provide a comprehensive update on TMS as a therapeutic intervention for SUDs, highlighting recent advancements and emerging areas of research.

Methods: This review explores the neurobiology underlying SUDs, emphasizing the roles of the prefrontal cortex, striatal circuits, and dopaminergic pathways, and examines how TMS modulates neurocircuitry to impact addiction-related behaviors. We discuss TMS procedural aspects and provide a comparative analysis of TMS protocols, focusing only on repetitive, single-pulse, paired-pulse, and a more recent approach, theta burst stimulation. We review recent randomized clinical trials (RCTs) to demonstrate significant reductions in cravings and use across SUDs and emphasize the need for standardized protocols. We emphasize the power of combining neuroimaging techniques that highlight functional connectivity changes in the brain with TMS to identify potential biomarkers predictive of SUD treatment response, an often unexplored area of discussion.

Results & Conclusion: This review highlights the potential of TMS as a versatile and effective therapeutic modality for SUDs, especially when combined with neuroimaging. Key findings emphasize the necessity for future research to address methodological challenges, such as standardizing protocols and optimizing stimulation parameters. The integration of neuroimaging provides valuable insights into functional connectivity changes, enabling enhanced precision and individualized treatment strategies. By validating TMS approaches and incorporating multimodal techniques, this field can advance toward a more robust clinical utility in addressing the complex neurocircuitry of addiction-related behaviors underlying SUDs.

Keywords: Substance Use Disorder, Transcranial Magnetic Stimulation, Neurocircuitry, Dopamine, Prefrontal Cortex, Randomized Controlled Trials, Neuroimaging
