Psychiatria Danubina, 2025 Vol. 37, No. 2, pp 257-261 https://doi.org/10.24869/psyd.2025.257 *Case Report*

High-frequency repetitive transcranial magnetic stimulation (rTMS) in the treatment of post-traumatic stress disorder: A case report

Nurten Arslan Işık[1], Ulrike Maria Schneider[2], Bettina Grager[2] & Jan Di Pauli[2]

[1] Istanbul Medeniyet University, Faculty of Health Sciences, Department of Psychiatric Nursing, Istanbul, Turkey
[2] Rankweil Regional Hospital, Department of Adult Psychiatry, Austria

received: 25. 10. 2024; revised: 13. 3. 2025; accepted: 6. 5. 2025

* * * * *

INTRODUCTION

Overview of PTSD

Post-traumatic stress disorder (PTSD) is a debilitating neuropsychiatric disorder characterised by re-experiencing traumatic events, avoidance behaviours, negative changes in cognition and affect, and hyperarousal (Jakovljević et al., 2012, Ressler et al., 2022). Such experiences often leave lasting psychological effects. The lifetime prevalence of PTSD among adults is estimated to be 6-7%, although this rate may vary depending on environmental stressors and cultural contexts. Women have a higher risk of developing PTSD than men, largely due to increased exposure to sexual assault. Among military personnel, particularly war veterans, the prevalence can be as high as 30% (Jakovljević et al., 2012, Ressler et al., 2022). According to DSM-5, PTSD is diagnosed following exposure to a traumatic event such as actual or threatened death, serious injury, or sexual violence. Symptoms are classified into four main clusters: intrusion (e.g., flashbacks, nightmares), avoidance, negative changes in mood and cognition, and hyperarousal (e.g., irritability, sleep disturbances). Although many individuals initially experience acute stress symptoms, most recover naturally. However, approximately 10–20% develop persistent PTSD symptoms (American Psychiatric Association [APA], 2013; Norris & Sloane, 2007; Ressler et al., 2022).

The neurobiological basis of PTSD involves disrupted interactions between the amygdala, hippocampus and prefrontal cortex. Traumatic experiences lead to heightened sensitivity to threat signals, leaving individuals in a constant state of fear or stress. Hyperactivity in the amygdala contributes to persistent fear responses, while hypoactivity in the medial prefrontal cortex (mPFC) weakens the regulation of these responses. In typical functioning, the mPFC inhibits excessive amygdala activity, but in PTSD this regulatory mechanism is impaired (Shin et al., 2006; Kredlow et al., 2022). In addition, hippocampal atrophy, which is common in people with PTSD, impairs the ability to discriminate between threatening and non-threatening stimuli (Shin et al., 2006, Kredlow et al., 2022).

Conventional Treatment Approaches

No single pharmacological treatment completely alleviates the core symptoms of PTSD. However, the US Food and Drug Administration (FDA) has approved sertraline and paroxetine for symptom management. These medications are often integrated into broader treatment plans that include both trauma-focused and non-trauma-focused therapies to manage comorbid anxiety and depression (Kelmendi et al., 2017; Krystal et al., 2017). Trauma-focused interventions, such as Prolonged Exposure (PE) and Cognitive Processing Therapy (CPT), directly address trauma-related thoughts, memories, and emotions. Non-trauma-focused approaches, including relaxation techniques, stress inoculation training (SIT), and interpersonal therapy, aim to reduce symptoms without directly addressing traumatic memories (APA, 2004; National Institute for Health and Care Excellence [NICE] 2005; Institute of Medicine, 2007). A major challenge in the treatment of PTSD is the high dropout rate, with one meta-analysis reporting that approximately 18% of patients discontinue treatment prematurely (Hembree et al., 2003; Imel et al., 2013). Furthermore, the adverse effects of psychotherapeutic interventions remain poorly understood, and residual symptoms often persist after treatment, with therapeutic benefits lasting between 6 and 20 months (Cusack et al., 2016; Rauch et al., 2023).

Transcranial Magnetic Stimulation (TMS) and Dorsolateral Prefrontal Cortex (DLPFC) Targeting in PTSD Treatment

Transcranial magnetic stimulation (TMS) has emerged as a promising non-invasive treatment modality for PTSD due to its minimal side effects, rapid onset of action, and growing evidence of efficacy in treatment-resistant cases. TMS operates on Faraday's principle of electromagnetic induction, wherein a magnetic coil placed on the scalp generates rapidly changing electrical currents. These currents produce a magnetic field that penetrates the scalp, skull, and cerebrospinal fluid with minimal resistance, inducing electrical currents at the cortical level. These currents depolarize neurons and trigger action potentials that propagate through neural circuits (Zeeuws et al., 2010; Camprodon & Pascual-Leone, 2016).

Repetitive TMS (rTMS) delivers magnetic pulses in a series over specific cortical regions. Depending on the frequency, it can either increase (excitatory) or decrease (inhibitory) neuronal activity (Rossi et al., 2009; Zorzo et al., 2019; Işık et al., 2024). High-frequency rTMS (≥10 Hz), in particular, has been shown to enhance cortical excitability and functional connectivity within prefrontal-limbic circuits, contributing to improved emotional regulation (Pascual-Leone et al., 2000; Fitzgerald et al., 2006).

Functional neuroimaging studies have identified a dysregulated neural circuit in individuals with PTSD, primarily involving the amygdala, hippocampus, ventromedial prefrontal cortex (vmPFC), and dorsolateral prefrontal cortex (DLPFC) (Shin et al., 2006; Koenigs & Grafman, 2009). As illustrated in Figure 1, the amygdala exhibits hyperresponsiveness, contributing to heightened fear and threat responses. In contrast, both the vmPFC and DLPFC are typically hyporesponsive, reducing top-down regulatory control over emotional reactivity. The hippocampus, which plays a key role in contextual memory processing, also demonstrates structural and functional abnormalities in PTSD. The impaired functioning of this circuit underlies many of the core PTSD symptoms, including emotional dysregulation, intrusive memories, and heightened arousal. Given the DLPFC's critical role in modulating this network, it has become a primary target in neuromodulation therapies such as rTMS.

By stimulating the DLPFC, rTMS may help restore this regulatory balance, thereby reducing core PTSD symptoms such as hyperarousal, re-experiencing, and negative mood alterations (Boggio et al., 2010; Leong et al., 2020; McGirr et al., 2021). While early studies primarily targeted the left DLPFC based on depression protocols, emerging evidence suggests that right DLPFC stimulation may be more effective for PTSD, given its stronger involvement in emotional reactivity and arousal modulation (Kozel et al., 2019; Philip et al., 2019). Moreover, targeting the DLPFC may facilitate neuroplasticity and promote long-term improvements in cognitive-emotional processing and trauma integration (Philip et al., 2022).

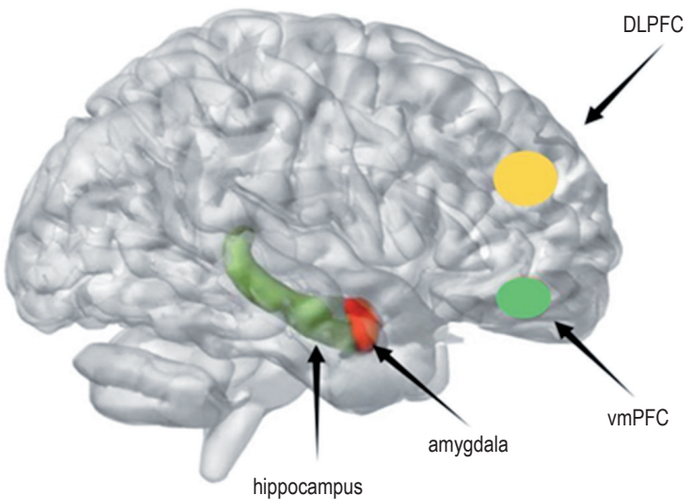

Figure 1. Key brain regions implicated in posttraumatic stress disorder (PTSD). The image illustrates the amygdala (red), hippocampus (green), ventromedial prefrontal cortex (vmPFC; green circle), and dorsolateral prefrontal cortex (DLPFC; yellow circle), which form a dysregulated neural circuit commonly identified in individuals with PTSD. Functional neuroimaging studies have demonstrated hyperactivation of the amygdala and hypoactivation of the prefrontal regions, contributing to impaired fear regulation and emotional processing (Koenigs & Grafman, 2009; Shin et al., 2006).

In light of the aforementioned literature, this report presents the case of a 38-year-old female patient diagnosed with PTSD who underwent a 10-session high-frequency (10 Hz) rTMS protocol targeting the right DLPFC. Although the patient initially showed a positive response to treatment, her co-occurring alcohol dependence posed a challenge to the therapeutic process. The aim of this case report is to explore the clinical applications and potential benefits of rTMS in the treatment of PTSD, supported by current evidence. Written informed consent was obtained from the patient for the publication of this report.

CASE REPORT

A 38-year-old female patient presented to our clinic with complaints of recurrent flashbacks, anxiety, hostility, nightmares and severe sleep disturbance. She reported a history of multiple traumatic events that had significantly affected her mental health. Following the divorce of her parents at the age of 14, she lived with her stepmother and stepsiblings, during which time she was sexually, physically and emotionally abused. In addition to her childhood adversities, the patient faced significant challenges during her marriage and motherhood. From the age of 28, she reported heavy alcohol use as a coping mechanism to deal with traumatic experiences and flashbacks. Her first admission to our clinic followed an episode of alcohol intoxication that occurred after she attacked her husband with a knife during a domestic dispute. The patient had difficulty maintaining sobriety and had been hospitalised several times. Despite several attempts at treatment, her symptoms had not improved in recent years. On clinical assessment, she appeared tense and irritable, avoiding eye contact and displaying a defensive posture. Although there were no obvious signs of physical neglect, discussion of past traumatic events caused her to become agitated and to have difficulty regulating her emotions. The patient had previously received several interventions, including psychopharmacological treatments such as selective serotonin reuptake inhibitors (SSRIs), pregabalin, and prothipendyl. She also attended regular psychotherapy sessions. However, the severity of her symptoms limited her response to these interventions. Because of the continued risk of harm to herself or others, she gave written informed consent to begin rTMS therapy.

The rTMS protocol was designed according to evidence-based guidelines for the therapeutic use of rTMS in PTSD (Lefaucheur et al., 2020). Stimulation intensity was set at 100% of motor threshold at a frequency of 10 Hz. Each session consisted of 20 minutes of stimulation, for a total of 2000 pulses per session. The patient completed 10 sessions over two weeks, with one session per day, excluding weekends. She tolerated the treatment well, with mild headache being the only reported side effect. The patient showed a marked improvement in PTSD symptoms during the rTMS treatment. Initially, she reported experiencing daily flashbacks; however, by the end of treatment, the frequency decreased to five flashbacks per day and eventually ceased altogether. The resolution of her nightmares greatly reduced her distress and contributed to a more positive emotional state. Upon discharge, she expressed a strong desire to continue rTMS treatment on an outpatient basis. Despite the initial positive response, the patient resumed alcohol consumption shortly after discharge, resulting in a relapse of symptoms and a readmission to hospital. Unfortunately, due to an early discharge during her subsequent hospitalisation, the planned continuation of rTMS treatment could not be implemented. While her initial response to rTMS was encouraging, her relapse into alcohol use as a means of coping with flashbacks undermined the therapeutic process and highlighted the need for comprehensive management of co-occurring substance use.

DISCUSSION

This case report examines the effects of 10 sessions of high-frequency (10 Hz) rTMS targeting the right DLPFC in a 38-year-old female patient with treatment-resistant PTSD and co-occurring alcohol use disorder (AUD). Prior to rTMS, the patient experienced limited improvement with both pharmacological and psychotherapeutic interventions and continued to struggle with severe flashbacks, anxiety, nightmares, and sleep disturbances.

Following rTMS treatment, a notable reduction in traumatic flashbacks and nightmares was observed, indicating a direct therapeutic benefit of the intervention. The 10-session rTMS protocol applied to the right DLPFC appeared to exert a rapid ameliorative effect on core PTSD symptoms, likely due to its impact on emotional regulation and neural excitability. The literature supports that stimulation of the right DLPFC exerts an inhibitory effect on the amygdala, reducing hyperarousal and improving emotional regulation (Koenigs & Grafman, 2009; Boggio et al., 2010). Additionally, high-frequency rTMS promotes neuroplasticity, strengthening synaptic connections and facilitating better processing of traumatic memories (George & Post, 2011).

In this case, the patient's significant reduction in both flashbacks and nightmares contributed to improvements

in her overall emotional state and quality of life. Motivated by her progress, the patient expressed a desire to continue rTMS treatment on an outpatient basis.

However, despite these initial improvements, the treatment outcomes were later compromised by a relapse into alcohol use. This clinical development underscores the complexity of treating comorbid PTSD and AUD. Research suggests that alcohol use significantly disrupts prefrontal cortex functioning, impairs impulse control, and interferes with the cognitive-emotional regulation necessary for trauma recovery (Sullivan & Pfefferbaum, 2005). As the prefrontal cortex plays a critical role in decision-making and emotion regulation, alcohol-induced damage to this region may exacerbate PTSD symptoms and reduce the effectiveness of rTMS. Furthermore, ongoing alcohol use may counteract the neuroplastic effects of rTMS, weakening synaptic connections and limiting long-term treatment efficacy (Hanlon et al., 2015, Koob & Volkow., 2016).

In this case, the patient's initial symptom relief can be primarily attributed to the neurophysiological effects of rTMS. However, the subsequent relapse into alcohol use—rather than an inherent limitation of rTMS—appears to have been the main factor leading to symptom recurrence and treatment resistance. This distinction is crucial for understanding the separate and interacting roles of neuromodulation and substance use in treatment outcomes.

The high prevalence of AUD in individuals with PTSD is well documented, with research suggesting that approximately 42% of PTSD patients meet criteria for AUD (Pietrzak et al., 2011). This case highlights the need for integrated approaches that simultaneously address both PTSD and co-occurring substance use disorders to ensure sustained recovery.

While this case demonstrates the potential benefits of rTMS in the treatment of PTSD, several limitations must be considered. First, the findings are based on a single case, which limits the generalisability of the results. Future research with larger and more diverse patient populations, including individuals of different ages, genders, and trauma histories, is essential to provide more robust evidence for the efficacy of rTMS. Second, the patient's AUD complicated the treatment process, making it difficult to isolate the effects of rTMS on PTSD symptoms.

The presence of a substance use disorder may have influenced treatment outcomes, and future research should explore the impact of comorbid conditions on the efficacy of rTMS in the treatment of PTSD. In addition, the long-term effects of the rTMS protocol used in this case remain unclear. Although the patient experienced significant symptom relief during the short-term intervention, her relapse into alcohol use prevented an assessment of the long-term sustainability of the treatment. Future studies should include longer follow-up periods to assess the durability of rTMS results. Comparative studies investigating the efficacy of different stimulation frequencies, intensities, and session protocols would also be beneficial in optimising treatment strategies. Finally, further research is needed to develop integrated treatment models that combine rTMS with interventions for co-occurring psychiatric disorders, such as AUD. As substance use disorders may interfere with the therapeutic effects of rTMS, multidisciplinary approaches addressing both addiction and PTSD symptoms are crucial. Future studies should evaluate the effectiveness of integrated treatment frameworks to maximise the benefits of rTMS in clinical practice.

CONCLUSIONS

This case report highlights the potential of high-frequency rTMS as a safe and effective treatment for PTSD, particularly in alleviating persistent symptoms such as flashbacks and nightmares. However, as demonstrated in this case, the long-term success of rTMS depends on the concurrent treatment of comorbid conditions such as alcohol dependence. Addressing these underlying issues is essential to achieve sustainable therapeutic outcomes and optimise the benefits of rTMS in the treatment of PTSD.

Ethical Considerations: Does this study include human subjects? NO

Conflict of interest: No conflict of interest

Funding sources: The authors received no funding from an external source.

Authors Contributions: Nurten Arslan Işık: study design, data collection, first draft, approval of the final version. Ulrike Maria Schneider: applying the treatment, study design, data collection, first draft, approval of the final version. Bettina Grager: applying the treatment, study design, data collection, first draft, approval of the final version. Jan Di Pauli: applying the treatment, study design, data collection, first draft, approval of the final version

References

Alexandra Kredlow, M., Fenster, R. J., Laurent, E. S., Ressler, K. J., & Phelps, E. A. (2022). Prefrontal cortex, amygdala, and threat processing: Implications for PTSD. *Neuropsychopharmacology, 47*, 247–259.

Boggio, P. S., Rocha, M., Oliveira, M. O., Fecteau, S., Cohen, R. B., Campanhã, C., et al. (2010). Noninvasive brain stimulation with high-frequency and low-intensity repetitive transcranial magnetic stimulation treatment for posttraumatic stress disorder. *Journal of Clinical Psychiatry, 71*, 12852.

Camprodon, J. A., & Pascual-Leone, A. (2016). Multimodal applications of transcranial magnetic stimulation for circuit-based psychiatry. *JAMA Psychiatry, 73*, 407–408.

Cusack, K., Jonas, D. E., Forneris, C. A., Wines, C., Sonis, J., Middleton, J. C., et al. (2016). Psychological treatments for adults with posttraumatic stress disorder: A systematic review and meta-analysis. *Clinical Psychology Review, 43*, 128–141.

Fitzgerald, P. B., Oxley, T. J., Laird, A. R., Kulkarni, J., Egan, G. F., & Daskalakis, Z. J. (2006). An analysis of functional neuroimaging studies of dorsolateral prefrontal cortical activity in depression. *Psychiatry Research: Neuroimaging, 148*, 33–45.

George, M. S., & Post, R. M. (2011). Daily left prefrontal repetitive transcranial magnetic stimulation for acute treatment of medication-resistant depression. *American Journal of Psychiatry, 168*, 356–364.

Hanlon, C. A., Dowdle, L. T., Austelle, C. W., DeVries, W., Mithoefer, O., Badran, B. W., et al. (2015). What goes up, can come down: Novel brain stimulation paradigms may attenuate craving and craving-related neural circuitry in substance dependent individuals. *Brain Research, 1628*, 199–209.

Hembree, E. A., Foa, E. B., Dorfan, N. M., Street, G. P., Kowalski, J., & Tu, X. (2003). Do patients drop out prematurely from exposure therapy for PTSD? *Journal of Traumatic Stress, 16*, 555–562.

Institute of Medicine. (2007). *Treatment of PTSD: Assessment of the evidence*. Washington, DC: National Academies Press.

Işık, N. A., Grager, B., Neugebauer, J., & Di Pauli, J. (2024). The efficacy of high-frequency repetitive transcranial magnetic stimulation (rTMS) on functional (psychogenic) movement disorders. *Psychiatria Danubina, 36*, 118–122.

Imel, Z. E., Laska, K., Jakupcak, M., & Simpson, T. L. (2013). Meta-analysis of dropout in treatments for posttraumatic stress disorder. *Journal of Consulting and Clinical Psychology, 81*, 394.

Jakovljević, M., Brajković, L., Jakšić, N., Lončar, M., Aukst-Margetić, B., & Lasić, D. (2012). Posttraumatic stress disorders (PTSD) from different perspectives: A transdisciplinary integrative approach. *Psychiatria Danubina, 24*, 246–255.

Jakovljević, M., Brajković, L., Lončar, M., & Cima, A. (2012). Posttraumatic stress disorders (PTSD) between fallacy and facts: What we know and what we don't know? *Psychiatria Danubina, 24*, 241–245.

Kelmendi, B., Adams, T. G., Southwick, S., Abdallah, C. G., & Krystal, J. H. (2017). Posttraumatic stress disorder: An integrated overview of the neurobiological rationale for pharmacology. *Clinical Psychology: Science and Practice, 24*, 281.

Koob, G. F., & Volkow, N. D. (2016). Neurobiology of addiction: A neurocircuitry analysis. *The Lancet Psychiatry, 3*, 760–773.

Koenigs, M., & Grafman, J. (2009). Posttraumatic stress disorder: The role of medial prefrontal cortex and amygdala. *The Neuroscientist, 15*, 540–548.

Krystal, J. H., Abdallah, C. G., Averill, L. A., Kelmendi, B., Harpaz-Rotem, I., Sanacora, G., et al. (2017). Synaptic loss and the pathophysiology of PTSD: Implications for ketamine as a prototype novel therapeutic. *Current Psychiatry Reports, 19*, 1–11.

National Institute for Health and Clinical Excellence. (2005). *Posttraumatic stress disorder*. London: Gaskell.

Norris, R. H., Linke, S., Prosser, I. A. N., Young, W. J., Liston, P., & Bauer, N. (2007). Very-broad-scale assessment of human impacts on river condition. *Freshwater Biology, 52*, 959–976.

Pietrzak, R. H., Goldstein, R. B., Southwick, S. M., & Grant, B. F. (2011). Prevalence and Axis I comorbidity of full and partial posttraumatic stress disorder in the United States: Results from Wave 2 of the National Epidemiologic Survey on Alcohol and Related Conditions. *Journal of Anxiety Disorders, 25*, 456–465.

Ressler, K. J., Berretta, S., Bolshakov, V. Y., Rosso, I. M., Meloni, E. G., Rauch, S. L., et al. (2022). Post-traumatic stress disorder: Clinical and translational neuroscience from cells to circuits. *Nature Reviews Neurology, 18*, 273–288.

Rossi, S., Hallett, M., Rossini, P. M., Pascual-Leone, A., & Safety of TMS Consensus Group. (2009). Safety, ethical considerations, and application guidelines for the use of transcranial magnetic stimulation in clinical practice and research. *Clinical Neurophysiology, 120*, 2008–2039.

Shin, L. M., Rauch, S. L., & Pitman, R. K. (2006). Amygdala, medial prefrontal cortex, and hippocampal function in PTSD. *Annals of the New York Academy of Sciences, 1071*, 67–79.

Sullivan, E. V., & Pfefferbaum, A. (2005). Neurocircuitry in alcoholism: A substrate of disruption and repair. *Psychopharmacology, 180*, 583–594.

Zeeuws, D., Santermans, L., Baeken, C., & Vanderbruggen, N. (2010). Intensive rTMS applications in difficult to treat psychiatric patients: Some cases. *Psychiatria Danubina, 22*(Suppl 1), S135–S136.

Zorzo, C., Higarza, S. G., Méndez, M., Martínez, J. A., Pernía, A. M., & Arias, J. L. (2019). High frequency repetitive transcranial magnetic stimulation improves neuronal activity without affecting astrocytes and microglia density. *Brain Research Bulletin, 150*, 13–20.

Correspondence:
Prof. Nurten Arslan Işık
Istanbul Medeniyet University, Faculty of Health Sciences, Department of Psychiatric Nursing, Istanbul, Turkey
nurtenarslanisik1@gmail.com