

## Transcranial Magnetic stimulation in Psychiatry: Past, Current and Future

### Psikiyatride Transkraniyal Manyetik Uyarım: Geçmiş, Şimdi ve Gelecek

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#### ABSTRACT

Transcranial Magnetic Stimulation (rTMS) is a novel non-invasive neuromodulation method applied via a coil to the skull surface of the patient stimulating relevant brain regions. Replicating data suggest the therapeutic role of repetitive transcranial magnetic stimulation (rTMS) in many psychiatric diseases though there are limited human neuroprotective data. Here we aimed to evaluate the therapeutic role of rTMS from a multifaceted perspective, including its effects on the neuroplasticity and neuroprotection processes. As a conclusion, rTMS seems to offer a potential for neuroprotective therapy.

Keywords: Transcranial Magnetic Stimulation; Neuroprotection; Psychiatric Diseases; Neuroplasticity

#### ÖZ

Transkraniyal Manyetik Uyarım (TMU), hastanın kafatası yüzeyine bir bobin aracılığıyla uygulanarak ilgili beyin bölgelerini uyaran yeni bir non-invaziv nöromodülasyon yöntemidir. İnsan çalışmalarında nöroprotektif etkisine dair kanıtlar sınırlı olsa da, yinelenen veriler, birçok psikiyatrik bozuklukta TMU'nun terapötik rol oynadığını düşündürmektedir. Bu yazıda nöroplastisite ve nöroproteksiyonun süreçler üzerindeki etkileri de dahil olmak üzere, çok yönlü bir bakış açısıyla TMU'nun terapötik etkisini araştırdık. Sonuç olarak, TMU, nöroprotektif tedavi için bir potansiyel sunuyor gibi görünmektedir.

Anahtar Kelimeler: Transkraniyal Manyetik Uyarım; Nöroproteksiyon; Psikiyatrik Hastalıklar; Nöroplastisite

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#### Introduction

Historically, the development of the TMS is has been shown to relate with the discovery of higher brain functions involving the unique topographical organization ability of the brain<sup>1</sup>. Magnetic stimulation, in other words, transcranial magnetic stimulation (TMS), is applied via a coil to the skull surface of the patient. Faraday firstly discovered the mechanism of TMS based on a

simple principle of electromagnetic stimulation: The magnetic field derived from the electrical energy may, in turn, induce a secondary electric field that stimulates relevant brain regions. With modern transcranial magnetic stimulation development, TMS was a preferred method in many neurology and psychiatric disciplines<sup>1</sup>.

Basics and Clinical Applications

Since 2008 rTMS is an FDA (Food and drug administration) approved anti-depressant therapy in the United States. Furthermore, TMS has also been suggested to treat several other psychiatric diseases such as mania, OCD and schizophrenia. Therapeutically, there are two basic forms of TMS applications. The single-pulse TMS is used primarily for scientific and diagnostic purposes, while the repetitive TMS ( rTMS ), consisting of repetitive pulses, is used mainly for therapeutic purposes. Also, different frequencies of rTMS have divergent effects. For instance, High-frequency rTMS ( > 5 Hz) increases the cortical excitability, while lower frequencies ( < 5 Hz) decrease the motor excitability<sup>2</sup>. As mentioned above, rTMS is a preferred therapeutic method in the psychiatry discipline, especially when it comes to depression. The major advantage of this novel method is that it is not painful and does not require anaesthesia like other invasive stimulation methods, such as electro-convulsive therapy<sup>2,3</sup>. Furthermore, TMS does not alter consciousness, and technically it can penetrate the scalp, skull and brain cortex without inducing seizure activity<sup>1,2</sup>. Shortly, TMS is a safe, non-invasive and well-tolerated therapy method with very mild side effects, including mild headaches responding well to simple analgesics.

### Alternative Mechanisms

Although the mechanism of its action seems mechanistic, many effects could not be simply explained with its stimulation effect on the cortex. For instance, many experimental studies have revealed that TMS might exert a neuroprotective and neuroplasticity inducing effect in addition to its anti-depressant effects<sup>3,4,5</sup>. For instance, rTMS (at high frequencies) induced neuronal plasticity similar to many anti-depressants suggesting that rTMS's anti-depressant effects might also involve restoring the impaired neuroplasticity process in depression<sup>6</sup>. Further neurochemistry and neurobiology studies elucidating the underlying mechanisms of the TMS finally showed that TMS might not only change the electrical activity but also lead to some critical changes in critical anti-depressant and neuroprotective molecules<sup>7</sup>. For instance, in several animal and human studies, BDNF, a well-known pro-cognitive, anti-depressant and neuroprotective molecule, is increased after rTMS<sup>6,7</sup>. Since no

cognitive side effects are described with rTMS, this opened a new window of the therapeutic role of ATMs in neurodegenerative diseases such as Alzheimer's and Parkinson's Disease<sup>8</sup>. Considering the role of neurodegeneration also in some psychiatric diseases, rTMS might be a novel tool with its additional neuroprotective effect. Although there are no conclusive human studies in this respect, animal data, including many psychiatric neurodegeneration models, are rapidly replicating<sup>6,7,8</sup>.

**Conclusion:** TMS is a novel tool for many neurological and psychiatric diseases. Beyond the time and location of stimulation, TMS can also modulate brain chemistry and network activity, offering the potential for neuroprotective therapy.

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