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Transcranial Magnetic stimulation in Neurodegenerative Diseases: Basics and Clinical Applications

Nörodejeneratif Hastalıklarda Transkraniyal Manyetik Uyarım: Temeller ve Klinik Uygulamalar

Burak Yulug[1], Ahmet Aslan[2*]

1.Alanya Alaaddin Keykubat University, Department of Neurology and Neuroscience, School of Medicine, Antalya, Turkey
2.Alanya Alaaddin Keykubat University, Department of Orthopedic surgery, School of Medicine, Antalya, Turkey

ABSTRACT

Transcranial Magnetic Stimulation (rTMS) non-invasively modulates brain networks via stimulating relevant brain regions responsible for motor and cognitive functions. However, replicating human and animal data suggests the therapeutic role of repetitive transcranial magnetic stimulation (rTMS) in many neurological diseases. In this paper, we evaluate the role of rTMS on the network neuroplasticity and neuroprotective pathways, including especially the Brain-Derived Neurotrophic Factor (BDNF), which mediates the pro-cognitive and neuroprotective effects of rTMs, suggesting that rTMS is a potential neuroprotective and pro-cognitive therapy.

Keywords: Transcranial Magnetic Stimulation; Neuroprotection; Neurological Diseases; Neuroplasticity; BDNF; Alzheimer'Disease; Parkinson's Disease

ÖZ

Transkraniyal Manyetik Stimülasyon (rTMS), motor ve bilişsel işlevlerden sorumlu ilgili beyin bölgelerini uyararak beyin ağlarını non-invaziv olarak modüle eder. Bununla birlikte, insan ve hayvan verilerinin kopyalanması, birçok nörolojik hastalıkta tekrarlayan transkraniyal manyetik stimülasyonun (rTMS) terapötik rolünü ortaya koymaktadır. Bu yazıda, özellikle rTM'lerin bilişsel ve nöroprotektif etkilerine aracılık eden Beyinden Türetilmiş Nörotrofik Faktör (BDNF) dahil olmak üzere, rTMS'nin ağ nöroplastisitesi ve nöroprotektif yolaklar üzerindeki rolünü gözden geçirdik. BDNF rTM'lerin bilişsel ve nöroprotektif etkileri, rTMS'nin potansiyel bir nöroprotektif ve pro-bilişsel terapi olduğunu düşündürmektedir.

Anahtar Kelimeler: Transkraniyal Manyetik Uyarım; Nöroproteksiyon; Nörolojik Hastalıklar; Nöroplastisite; BDNF; Alzheimer hastalığı; Parkinson hastalığı

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*Ahmet Aslan, MD, Medical School of Alaaddin Keykubat University, Department of Orthopedics and Traumatology, Alanya/Antalya, Turkey., Turkey, +905056462411 ahmet.aslan@alanya.edu.tr

ORCID: 0000-0001-5797-1287

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Introduction

Transcranial magnetic stimulation (TMS) is a non-invasive electromagnetic stimulation procedure applied to the skull surface of the patient, which induces a secondary electric field that stimulates relevant brain regions based on magnetic fields1. Therefore, with the advancement of new techniques, transcranial magnetic stimulation has become a preferred method in many neurology disciplines2-4, especially when it comes to network-based neuroprotection approaches in humans and animals.

Basics and Clinical Application

Despite some differences in its application procedures, such as single-pulse TMS and repetitive TMS (rTMS), which are consisting single-pulse stimulation and a series of repetitive

pulses, respectively, both procedures modify the network properties of many neurological diseases, especially neurodegenerative diseases, such as Alzheimer's Disease and Mild Cognitive Impairment 5. Beyond that, TMS has also treat several psychiatric diseases while it has been an FDA approved anti-depressant therapy in the United States since 20085-6.

Although different frequencies of rTMS have divergent effects showing increased and decreased motor excitability when applied at High (> 5 Hz)and low –frequencies rTMS (< 5 Hz) 2, respectively, many experimental studies have revealed that TMS might exert a preclinical neuroprotective and neuroplasticity modifying effect in several studies2-4. A good example is that rTMS could modify clinical network and neurochemical parameters in many animal and human studies. In addition to some cognitive networks, these parameters include some critical neuroprotective molecules, including especially the BDNF. BDNF is a well-known neuroprotective molecule that exerts significant pro-cognitive and neuroprotective properties7-8. Furthermore, it also induces synaptogenesis which is hypothesized to mediate the neuroprotective and anti-depressant effect of rTMS2,7-8. Also, with its cognitive side effect profile, rTMS might be a suitable option in neurodegenerative diseases characterized by cognitive impairment such as Alzheimer's Disease5,8,9 and Parkinson's Disease5,10

It should also be mentioned that with the proven role of neurodegeneration in many neurodegenerative diseases, rTMS might be a novel tool with its additional neuroprotective and pro-cognitive effects. Thus there are rapidly replicating evidence showing the pro-cognitive and neuroprotective role of rTMS5-10.

Conclusion

TMS is a suitable non-invasive stimulation method for many neurological diseases. Beyond its well-accepted working principles, it can also lead to distant central nervous system effects, including the modulation of molecules and networks responsible for neuroprotection and cognition. Therefore, there is an unmet need for additional human clinical trials to confirm its well-known neuroprotective effects in experimental studies, which could be a game-changer therapy option in human neurodegenerative diseases, primarily are characterized by cognitive dysfunction.

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Author / ORCID	Authorship Contrubition
Burak Yuluğ 0000-0002-9704-6173	Consept and design, literature review, manuscript writing, final approval.
Ahmet Aslan 0000-0001-5797-1287	Interpretation, critical review, final approval.