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## Review Article

# Repetitive Transcranial Magnetic Stimulation (RTMS) for the Treatment of Depression, Migraine and Parkinson's Disease

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**Abstract:** Repetitive transcranial magnetic stimulation (RTMS) is newest methodology for treatment of various neurological and psychiatric disorders including migraine, stroke, Parkinson's disease ,dystonia, tinnitus and depression. It basically involves induction of electromagnetic pulses instead of electrical current to activate the brain. An electromagnetic coil is held against the forehead and short electromagnetic pulses are administered through the coil using a rapidly changing magnetic field. The magnetic pulse easily passes through the skull, and causes small electrical currents that stimulate nerve cells in the targeted brain region. This type of pulse generally does not reach further than two inches into the brain. The magnetic field is about the same strength as that of a magnetic resonance imaging (MRI) scan.
**Keywords:** ***P***arkinson's disease, depression, migraine, repetitive transcranial magnetic stimulation.

## INTRODUCTION

Brain stimulation therapies involve activating or touching the brain directly with electricity, magnets, or implants to treat depression and other disorders. Other stimulation therapies prevalent are — vagus nerve stimulation, magnetic seizure therapy, and deep brain stimulation. Repetitive Transcranial Magnetic Stimulation (rTMS) involves targeting specific areas of brain that are believed to be affected by depression and other mood disorders. It has the ability to selectively modulate or change activity in small areas of the brain [1-2].

Treatment influences the electrical activity in the brain by means of a pulsed magnetic field. The magnetic field is generated by passing brief current pulses through a figure-8 coil of wire [3]. This coil of wire is encased in plastic and held close to the scalp so that the magnetic field can be focused onto specific areas of the cortex, or surface, of the brain. The magnetic field that is generated in rTMS can penetrate the scalp and skull safely and painlessly to induce a current in specific neurons (brain cells).Because the magnetic stimulation is delivered at regular intervals, it is termed repetitive TMS, or rTMS. Stimulation parameters, such as the number of stimuli, the strength of the stimuli, the duration of the stimuli, and the length of the interval between stimuli can all be varied [4]. The ability to change parameters while directly targeting specific brain cells suggests that rTMS therapy has an extremely valuable therapeutic potential and treatment can be customized for each patient.

**Fig-1: Eight shaped RTMS Device**

## WORKING OF RTMS

Transcranial magnetic stimulation (TMS) utilizes an electromagnet placed on the scalp that generates magnetic field pulses roughly the strength of an MRI scan. The magnetic pulses stimulate a small area on the surface of the brain about the size of a

quarter. Low frequency (once per second) TMS has been shown to induce small, sustained reductions in activity in the part the brain that has been stimulated [5].

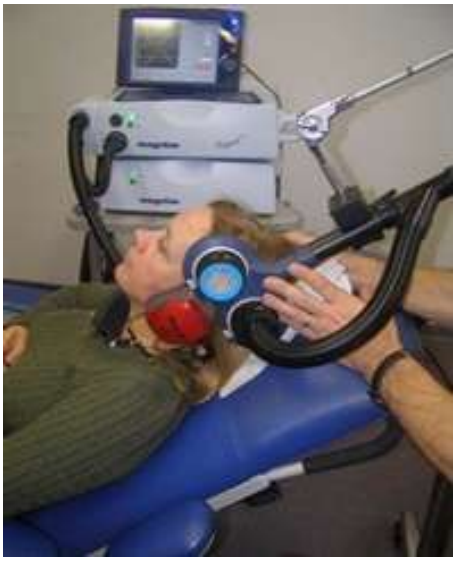

**Fig. 2 RTMS Device in operation**

From the Biot-Savart Law

$$\mathbf{B} = \frac{\mu_0}{4\pi} I \int_C \frac{d\mathbf{l} \times \hat{\mathbf{r}}}{r^2} \quad \text{... [1]}$$

it has been shown that a current through a wire generates a magnetic field around that wire. Transcranial magnetic stimulation is achieved by quickly discharging current from a large capacitor into a coil to produce pulsed magnetic fields of 1-10 mT [6,7] By directing the magnetic field pulse at a targeted area of the brain, one can either depolarize or hyperpolarize neurons in the brain. The magnetic flux density pulse generated by the current pulse through the coil causes an electric field due to the Maxwell-Faraday equation,

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \quad \text{. ... [2]}$$

This electric field causes a change in the transmembrane current of the neuron, which leads to the depolarization or hyperpolarization of the neuron and the firing of an action potential [8] .

**DURATION OF RTMS**

It depends on the treatment/research protocol, but generally each session takes about 20 minutes. Treatment protocols vary in duration, but most require at approximately 10-15 sessions given five times per week [9].

**PROPERTIES OF RTMS**

1. RTMS has some very unique properties.
2. It is non-invasive, can easily be focused on small areas of the brain, and can modulate the brain cortex at selected site. This makes it particularly well suited for treating several brain disorders, while minimizing side effects [10].
3. rTMS has been shown to be effective in several psychiatric disorders not responding with currently available medication and other therapies [11].
4. The rTMS can be also useful in some patients who are not able to take medications [12].
5. The techniques can be used in the following conditions:
    1. Depression
    2.Vascular Depression (Depression because of stroke).
    3. Obsessive compulsive disorder
    4. Migraine
    5.Resistant auditory hallucination in Schizophrenia
    6. Depression associated with parkinsonism disease
    7. Post traumatic stress disorder Schizophrenia with negative symptoms Chronic tinnitus

**EFFECTS ON THE BRAIN**

The exact details of how TMS functions are still being explored. The effects of TMS can be divided into two types depending on the mode of stimulation:

Single or paired pulse TMS causes neurons in the neocortex under the site of stimulation to depolarize and discharge an action potential. If used in the primary motor cortex, it produces muscle activity referred to as a motor evoked potential (MEP) which can be recorded on electromyography [13-14]. If used on the occipital cortex, 'phosphenes' (flashes of light) might be perceived by the subject. In most other areas of the cortex, the participant does not consciously experience any effect, but his or her behaviour may be slightly altered (e.g., slower reaction time on a cognitive task), or changes in brain activity may be detected using sensing equipment [15-16].

Repetitive TMS produces longer-lasting effects which persist past the initial period of stimulation. rTMS can increase or decrease the excitability of the corticospinal tract depending on the intensity of stimulation, coil orientation, and frequency [17,18]. The mechanism of these effects is not clear, though it is widely believed to reflect changes in synaptic efficacy akin to long-term potentiation (LTP) and long-term depression (LTD) [19-20].

**CONCLUSION**

Thus, we have successfully studied RTMS and its various effects and diseases it can combat.

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