SPECIAL ARTICLE

THE EMERGING ROLE OF REPETITIVE TRANSCRANIAL MAGNETIC STIMULATION IN TREATING THE MENTAL CONDITION

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ABSTRACT

Repetitive Transcranial Magnetic Stimulation (rTMS) is a form of brain stimulation therapy, approved by FDA (USA) and CE (Europe). During rTMS treatment, an instrument known as a stimulator delivers electrical energy to a magnetic coil, which generates a magnetic field in the brain for a brief period. rTMS is based on the principle of electromagnetic induction, which can either stimulate or inhibit neuronal activity in specific brain areas as required. This drug-free treatment is helpful in many neurological and psychological disorders such as depression, OCD, migraines, autism, ADHD, epilepsy, Bipolar and sexual disorders. The treatment is so safe that it could be conducted across a wide range of age groups, from children to seniors. It is an outpatient procedure, which does not require hospitalization or anesthesia and entails no memory loss. Patients do not require any recovery time after the session and can resume their normal activities immediately. Other than some precautions, it is often ideal for patients, because it has none of the side effects of traditional medications and other treatments. It can be said that rTMS is a focal, non-invasive and very well-tolerated form of brain stimulation in clinical use that is safe for most patients suffering from mental or psychological disturbances.

KEYWORDS

RTMS, Mental health, Treatment age, Depression, Anxiety, OCD, Mania

INTRODUCTION

In 1831, an English scientist named Michael Faraday argued that the relation between electrical energy and magnetic field was reciprocal.[1] To check the relationship, some studies were conducted on the use of magnetic coils over a person's head over time. The current use of electromagnetic induction for transcranial stimulation dates back to 1985 when Barker and his colleagues invented an initial type of TMS in Sheffield, UK.[2] Repetitive Transcranial Magnetic Stimulation (rTMS), is a variation of TMS.[3] It is a painless, non-invasive, non-drug & safest neuromodulation technique. For years, this technology has been used more in the diagnosis and treatment of neuropsychiatric areas. In January 2013, the Clinical TMS Society was established with the mission to optimize clinical practice, awareness, and accessibility of Transcranial Magnetic Stimulation therapy.[4]

The TMS technology works by altering the brain's neuronal activity while the patient feels no pain or pressure. Usually, the treatment for any neurological issue requires surgery or an invasive process in the skull and hence requires sedation, rTMS is a unique technique that would generate magnetic pulses that influence the brain's neural activity without any invasive process in the skull or sedation. In addition, the treatment's direct reach of deeper structures ensures prompt results due to its wider scope and high level of effectiveness. It has been also proven that the desired brain regions are captured during the process, without requiring any secondary navigation equipment and gives the best results.

rTMS and MENTAL HEALTH CONDITIONS

Many studies have shown rTMS is helpful in neurological problems such as Parkinson's Disease, Alzheimer, Dementia, Spinal Cord Injury, Peripheral Nerve Injury, Neuropathic Pain, Central Post Stroke Pain, Multiple Sclerosis, Stroke Complications (hand motor recovery, lower limb motor recovery, Dysphagia, Aphasia, Neglect) and Motor neuron disease. Moreover, TMS has been used to decrease and prevent epileptic seizures.[5]

As a non-invasive and painless treatment option, rTMS has also managed to provide the safest form of therapy for numerous mental health problems. Although major depressive disorder is a predominant mental disorder with significant morbidity, the public mental health knowledge about depression and its treatment is relatively poor.[6,7] Repetitive Transcranial Magnetic Stimulation (rTMS) treatment process has proven itself to treat a number of mental health problems along with depression. Transcranial Magnetic Stimulation (TMS) has been approved by various

health organizations across the globe for the treatment of multiple mental health conditions. The U.S. Food and Drug Administration (FDA) approved TMS in 2008 for the treatment of depression and in 2013; it was approved for treating the pain associated with certain migraine headaches8. TMS was also approved as a treatment for depression by the National Institute for Health and Care Excellence (NICE) (UK) in 2015. Repetitive Transcranial Magnetic Stimulation (rTMS) has also been approved for use in the treatment of depression in New Zealand, Israel, and many other countries. TMS treatment is also recognised and CE-marked in Europe for the treatment of a variety of mental health disorders.

It has been clinically demonstrated to offer relief from many mental health issues. Repetitive Transcranial Magnetic Stimulation (rTMS) treatment has a relatively very high level of effectivity, due to cutting-edge technology the magnetic pulses are directed deeply into the brain tissue. It affects the broader regions of the brain. Despite covering the broader region and deep brain tissue it maintains a safe level of activity. According to Carlos Peña, director of the Division of Neurological and Physical Medicine Devices in the FDA's Center for Devices and Radiological Health, "Transcranial magnetic stimulation has shown its potential to help patients suffering from depression and headaches" and "With today's marketing authorization, patients with OCD who have not responded to traditional treatments now have another option."[8] According to Chen L. and et al, rTMs is also effective in treating anxiety.[9] Cirillo P. and et al (2019) also found 95% success in treating GAD and PTSD.[10] TMS has also therapeutic effects on mania.[11]

Moreover, rTMS is best for patients who show resistance to other treatments. According to Perera et al (2016),[12] daily TMS treatment has significant evidence of efficacy and safety for treating the treatment-resistant or intolerant patients suffering from an acute phase of depression. Preliminary results of a study by Donaldson A E et al (2014) suggest that rTMS is an effective and well-tolerated treatment for adolescents with treatment-resistant depressive symptomology.[13] Conolly et al[14] also found TMS to be safe and effective in both acute and maintenance treatment of patients with treatment-resistant depression. Thus, rTMS is helpful in treating a wide range of mental disorders including Depression, Obsessive Compulsive Disorder, Substance Dependence, PTSD, Anxiety Disorder, Insomnia Disorder, Schizophrenia, Migraine and Bipolar disorder. It also helps with some of the pediatric issues such as Autism Spectrum Disorder and ADHD along with other issues such as sexual problems (in both males and females).

BENEFITS OF rTMS

According to Griffiths et al (2022).[15] rTMS has a positive impact on the individual's real-world functioning and quality of life. Other benefits include:

- Fast onset of action with significant patient improvement.
- It is provided as an outpatient procedure.
- Patients can return to normal activities right after the treatment.
- No anesthesia or sedation is required.
- No memory loss.
- Only 20-30 treatments over 4-6 weeks.
- The treatment time is short and varies between 20-30 minutes.
- It is safe even for children.[16]
- In some cases, it is better than conventional psychotherapy.
- TMS is an intermittent rescue strategy to prevent future relapse.[17]
- Most importantly, it does not affect other areas of the body as medications can.

MECHANISM OF rTMS

rTMS has been studied as a potential treatment for several psychiatric and neurological disorders. It is an application of recurring TMS pulses to a specific brain region. The neuromodulatory effects depend upon several stimulation parameters such as frequency, intensity, duration, cortical target, number of sessions and patient factors such as age, disorder and individual symptoms.[18] According to Wang X and et al, broadly, rTMS has been classified as high frequency (>1 Hz), which increases cortical excitability, and low frequency (<1 Hz), which reduces cortical excitability.[19] According to Morrison and et al[20] public perceptions of rTMS are somewhat poor. People usually get confused by rTMS with ECT. However, they both are different treatments with different functioning and side effects. rTMS is a noninvasive method of stimulating nerve cells in the brain. It works by activating neurons to stimulate or inhibit brain tissue and transmits a magnetic pulse through the skull. rTMS involves passing an electrical current through a wire coil placed on the scalp. There are various coils for various purposes and intensities. The current creates a magnetic field, which creates an electrical field in a specific part of the brain, causing nerve cells to depolarize and thus stimulating or disrupting brain activity.[21] A pulsed magnetic field generated by magnetic stimulation acts on the central and peripheral nervous systems and, a neuromodulation technique that causes changes in neuronal plasticity due to excitability of the nerve, release of the transmitter, local blood flow, and metabolic changes through pulsed magnetic fields of different frequency intensities.

The use of multi-channel neural modulation achieves the goal of treating pain. rTMS low-frequency stimulation can effectively reduce the excitability of the right hemisphere of the brain. The magnetic pulses are changing rapidly to alter the activity of neurons within the brain, because of which the neurons change their firing pattern with respect to induced magnetic pulses. The magnetic pulses within the circuit of the brain are responsible to change the firing pattern that is causing any mental health disorder. This changing neuronal

activity is the base of the mechanism of rTMS treatment. Unlike ECT no medication or anesthesia is required during or following the treatment. rTMS is fundamentally based on the concept of electromagnetic induction. It works in the brain by stimulating or inhibiting neuronal activity.

During the treatment process, the patient sits comfortably on a recliner chair or lies down on the bed to attain a comfortable position, and a coil in some cases along with cushioned helmet is placed over the patient's skull. As soon as the treatment starts, the coil starts sending magnetic pulses as per the protocol and activates or inhibits the neuronal activity in the brain. The pulses safely stimulate neurons in deep brain structures without causing any harm or unpleasant sensations. Typically, patients hear a tapping sound and feel a tapping sensation in the head area during the treatment. The patient remains conscious and can perform normal daily activities after the treatment. Each treatment time is 20-37.5 minutes (TBS is 3 minutes),[5] times a week, and roughly 20 times for one course of treatment which means 4-6 weeks. During the treatment, the stimulation intensity and stimulation frequency can be finely adjusted to avoid long-term stimulation of the same intensity and frequency, so that the patient adapts and reduces the curative effect. After the session, patients require no recovery period and are able to go about their daily activities immediately following the treatment. Patients who are unable to receive long-term treatment can reduce the frequency of treatment later, such as gradually reducing to weekly treatment to consolidate the efficacy. One of the most important things is that patients must inform them of a detailed history of seizures, brain damage or other severe medical conditions prior to sessions so the treatment is planned accordingly.

TREATMENT PROTOCOLS

rTMS sessions are conducted by trained operators who can be neurologists and psychiatrists. Under the supervision of the psychiatrist, an appropriately trained healthcare professional, such as a clinical psychologist or psychiatric nurse can also conduct the sessions.[22] rTMS operator is trained to operate the machine, select appropriate protocol, and most importantly recognize and effectively respond to seizures if the patient has a history of seizure.[23] The operator has to take care of the following also before the session starts.

- The operator must inform the patient of the principles, procedures and possible responses to the diagnosis and treatment in order to eliminate the patient's tension. Patient psychoeducation and comfort are essential while designing and administering the rTMS treatment.[24]
- Provide appropriate assistance to some patients with physical disabilities and inform the caregiver of the elderly and children.
- Remove the portable credit card, bank card, magnetic card key, disk, micro hard disk, mobile phone, MP4 and laptop to the outside of the treatment room to avoid magnetization.
- Inform patients undergoing treatment that they also need to remove metal glasses, belts, watches, necklaces, earrings and hearing aids devices.
- Give earplugs to the patient to protect hearing just in case the sound of the machine disturbs the patient.
- Position the stimulation site with the positioning cap.
- Choose a comfortable posture, sitting or lying position.

SIDE EFFECTS OR RISK ASSOCIATED WITH rTMS TREATMENT

rTMS is non-systemic, which means the side effects are contained in the treatment area and are not widespread throughout the body. It is most likely to be temporary discomfort at the treatment site.[25,26] rTMS is best for individuals who have had poor responses to pharmaceutical treatment and other therapies. rTMS therapy is often ideal for patients because it has none of the side effects of traditional medications and ECT. The most common side effects are temporary and mild headaches, pain on the stimulation site, fatigue,[27] muscle twitching and local discomfort. While at extremely low risk (approximately 0.1% per treatment course), the most serious side effect is a seizure (or fit).[28]

CONTRAINDICATIONS FOR rTMS

RTMS cannot be conducted under some conditions, such as:

- Patients with metallic objects or implanted stimulator devices in or near the head, including shunt, cochlear implants, deep brain stimulators, vagus nerve stimulators, other implanted electrodes or stimulators, aneurysm clips or coils.
- Patients who have any form of metal implanted in their body such as pacemakers, stents and bullet fragments.
- Metal piercing or tattoos with ferromagnetic ink in the head and neck region. Any non-ferromagnetic orthodontic hardware, for example, braces or fillings, is considered safe.
- Patient with increased intracranial pressure.
- A history of epilepsy who cannot accept high-frequency or high-intensity stimulation. (The frequency should be < 1Hz, and intensity should be <100%).
- Pregnant woman.
- Open wounds or low leukocyte counters.
- While patients with depression also have contraindications of an acute alcohol-dependence syndrome, use of drugs that cause a significant reduction in seizure threshold and severe or recent heart disease.[29]

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