Review article

Transcranial magnetic stimultation: scientific and modern technology for treatment of psychiatric and neurological disorders

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Summary

Extraordinary advances have been made in the treatment of mental illness. As a result, many mental health disorders can now be treated nearly as successfully as physical disorders. Transcranial Magnetic Stimulation (TMS) is one of the most scientific and modern techniques for treatment of neuropsychiatric disorders. Recently it has been introduced in Ashiyan Medical College Hospital, Dhaka, Bangladesh. The aim of this review article is to introduce this new intervention and provide a clinically useful update about it. For this purpose twenty three articles were selected through searching internet and then reviewed. This article summarized its use in neuro-psychiatric disorders, mechanism of action, adverse effects and outcome issues. It is used in clinical and research practice around the world by psychiatrists. More research is needed to establish the role of TMS in clinical practice in Bangladesh.

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Introduction

Extraordinary advances have been made in the treatment of mental illness. As a result, many mental health disorders can now be treated nearly as successfully as physical disorders. Many options are available for treating mental disorders such as drugs, electroconvulsive therapy and psychotherapy. Transcranial Magnetic Stimulation is the modern and scientific method for treating neuropsychiatric disorders. It directly activates or stimulates brain with magnets. The stimulated cells are thought to release chemical messengers (neurotransmitters), which help regulate mood and may thus relieve symptoms of psychiatric disorders. These procedures are typically used for people who do not respond to drugs or psychotherapy.[1] The aim of this review article is to provide a clinically useful update about transcranial magnetic stimulation, its use in psychiatric and neurological disorders, procedure, mechanism of action, adverse effects and outcome issues.

Materials and methods

Study documents were identified through Google Scholar and Health Internetwork Access to Research Initiative (HINARI). Information was also collected from texts and scientific documents. Used searching keys were mainly 'transcranial magnetic stimulation in psychiatric and neurological disorders', 'application and adverse effect of transcranial magnetic stimulation', etc. So full free articles focusing only on basic introduction of TMS were included. Both originals and review types were considered. Articles associated with other topics like differences between TMS other therapy, TMS in special age group, TMS therapy in diagnostic purposes were excluded. Thus total 23 articles were finally selected among 30 primarily selected articles and after reviewing findings were summarized.

Results and discussion

Overview: Transcranial Magnetic Stimulation (TMS) is powerful, non invasive tool, a pulsed magnetic field that create current flow in the brain to stimulate nerve cells in the brain.[2]

Types of TMS: Single-pulse transcranial magnetic stimulation (TMS) is a safe and useful tool for investigating various aspects of human neurophysiology. Repetitive TMS (rTMS) is a more powerful, capable of regional blocking or facilitating cortical processes. Although there is evidence that rTMS is useful for treating clinical depression, and possibly other brain disorders.[3]

How it works: Pulsed magnetic fields induce small electric currents in the prefrontal cortex of the brain that depolarize neurons and release neurotransmitters. It also activates limbic

system via neuronal pathways. It increase blood flow and glucose metabolism in the stimulated region that improves mood. Repeated activation of the left prefrontal cortex is shown to produce antidepressant effects in patients suffering from major depression.[4]

Procedure: During a Transcranial Magnetic Stimulation (TMS) procedure, a magnetic field generator coil is placed on anatomical landmark of skull. This coil produces small electric currents in the region of the brain just under the coil via electromagnetic induction. By directing the magnetic field pulse at a targeted area of the brain it can either depolarize or hyperpolarize neurons in the brain.[5]

Applications: TMS can be applied as single pulses or as a pair of pulses (paired-pulse TMS) separated by a given inter stimulus interval (ISI) and applied to the same or different brain areas, or as repetitive trains of stimulation (rTMS).[6] A conventional rTMS protocol for treating major depression typically consists of one to two treatment sessions per week or twice weekly.[7]

TMS therapy for diagnostic purpose: TMS is capable of causally assessing brain–behavior relationships, which has clear diagnostic implications for neurologic disorders. This is used diagnostically to measure the connection between the brain and muscle to evaluate damage from stroke, multiple sclerosis, amyotrphic lateral sclerosis, movement disorders and other disorders affecting the facial and cranial nerve.[8]

TMS therapy for treatment purpose:

Application of rTMS over primary auditory cortex appears to decrease tinnitus, and repeated sessions of rTMS to this region have been shown to induce more persistent suppression of tinnitus in several controlled studies.[9] TMS can be used to directly target a documented cortical seizure focus, or to stimulate an accessible cortical target connected to a subcortical focus. However, the antiepileptic efficacy of TMS is closely tied to the relative success of targeting the epileptogenic regions.

TMS can suppress cortical excitation possibly through GABAergic modulation.TMS can be used to directly target a documented cortical seizure focus, or to stimulate an accessible cortical target connected to a subcortical focus. However, the antiepileptic efficacy of TMS is closely tied to the relative success of targeting the epileptogenic regions.[10] Single pulse transcranial magnetic stimulation (sTMS) is a novel treatment for acute migraine. Previous randomized controlled data demonstrated that sTMS is effective and well tolerated in the treatment of migraine with aura.[11]

Repeated applications of TMS can influence brain plasticity and cortical reorganization through stimulation-induced alterations in neuronal excitability. These findings suggest that rTMS has good outcome in patients with traumatic brain injury.[12] rTMS over motor cortex after acute ischemic attack decreases disability.[13]

TMS therapy in Psychiatric Disorders: Repetitively administered TMS, when delivered to the dorsolateral prefrontal cortex (DLPFC), is an established treatment for treatment-refractory major depressive disorder. The efficacy of TMS in treating depression has been supported by large randomized, controlled trials and several meta-analyses.[14] TMS of left temporoparietal region decreases hallucinations in patients with schizophrenia.[15] High frequency rTMS of dorsolateral prefrontal cortex decreases negative symptoms of schizopheria[16] which shows improvement in compulsions like pathological gambling and binge-eating disorder. Its modulatory role in cortical mesolimbic pathways possibly implies improvement of the inhibitory control system and compulsive consumption drive. It also reduces the craving for substances like alcohol and cocaine.[17]

There is evidence that motor and premotor cortex are hyper excitable in obsessive–compulsive disorder and Tourette's syndrome. Low-frequency repetitive transcranial magnetic stimulation (rTMS) can normalize overactive motor cortical regions and thereby improve symptoms.[18] Modulation of prefrontal cortex can alleviate the core symptoms of Post Traumatic Stress Disorder and suggest that high-frequency rTMS of right prefrontal cortex might be the optimal treatment strategy.[19] Another study confirms that five daily sessions of high frequency rTMS over the left and then the right prefrontal cortex improves cognitive function in patients with mild to moderate degree of Alzheimer's Disease.[20]

Adverse effects: Although TMS is generally regarded as safe, short-term adverse effects of TMS includes syncope, seizure, discomfort or pain, transient induction of hypomania, transient cognitive changes, transient hearing loss and transient impairment of working memory.[21]

Contraindications: The only absolute contraindication is the presence of metallic hardware in close contact to the discharging coil (such as cochlear implants, or an Internal Pulse Generator or medication pumps). It is also contraindicated in patients with history of epilepsy or stroke, below 18 years old, patients medicated with drug lowering the seizure threshold, pregnant or nursing mother, patient with severe cardiac disease and patient suffering from vascular, traumatic, tumoral, or metabolic lesion of the brain.[22]

Advantages: It is safe, non-invasive, painless neuromodulation technique. It does not need anesthesia and it has no radiation hazards. It also has antidepressant effects.[23]

Prognosis: Repeated applications of TMS can influence brain plasticity and cortical reorganization through stimulation-induced

alterations in neuronal excitability. It offers the possibility of a much faster prognosis than other treatments. Repetitive TMS produces longer-lasting effects which persist past the initial period of stimulation.[15]

Conclusion

It is powerful noninvasive tool with less side effects that stimulate nerve brain. It has long lasting effect and rapid prognosis which also has demonstrated safety, efficacy and very good tolerability which has recently been established in Dhaka, Bangladesh. Awareness program regarding TMS and its outcome should be encouraged. Good communications between psychiatrists is needed for this purpose. More work and research is needed to establish the role of TMS in clinical practice in Bangladesh

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