Transcranial Magnetic Stimulation : A New Therapeutic Tool in Psychiatry

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Introduction

Transcranial magnetic stimulation (TMS) is an exciting development in the field of psychiatry. As a non-invasive technique, this was initially introduced in 1985 for inducing motor movement by direct magnetic stimulation of the brain [1]. The modality is used mainly in the treatment of depression. In spite of newer antidepressant drugs, significant percentages of depressed individuals do not respond to treatment. TMS provides the patients with same beneficial effects without the side effects of ECT.

TMS works on the principle that when a current is passed through a coil, a magnetic field is generated perpendicular to the current flow. By rapidly changing the magnetic field near a conducting medium such as brain, a current is generated which is parallel but opposite in direction to the current in the coil. In ECT also the cortical neurons are depolarised but the dose of current required is large due to the high resistance of the skull. In contrast TMS can stimulate the patient's cerebral cortex even while the patient is awake since the impedance does not affect the magnetic field. Focal stimulation can be given repeatedly unlike the ECT. The magnetic field used in TMS has the strength of 2 Tesla i.e. the same intensity as in magnetic resonance imaging. The TMS magnetic field declines logarithmically with distance from the coil. This limits the area of depolarisation to a depth of about 2 cm below the brain's surface.

The magnetic energy is typically delivered as a series of pulses. When delivered in this manner the technique is called as repetitive TMS (rTMS). Low frequency rTMS (< 1 Hz) is said to reduce the excitability of cortical neurons [2] whereas high frequency rTMS (>1 Hz) causes cortical excitability and increased cortical blood flow. [3,4] Positron emission tomography studies have

shown changes in cortical metabolism and blood flow following TMS [5-7].

The procedure is usually applied in outpatient settings. Unlike ECT, no anaesthesia is required and the procedure usually takes about 15 minutes. A magnetic coil is placed over the left or right prefrontal cortex. In research laboratories where precise brain mapping is required a mounted coil with EEG mapping is used. Both the patient and the operator use ear plugs to protect against the loud clicking noise produced by the rapid change in magnetic pulse. The patient usually feels a tingling sensation over the scalp and occasionally a twitch over the muscles of the face or hand. During the study of thousands of subjects, no one has reported that rTMS elicits memories, smells or complex psychological phenomena.

rTMS Studies in Depression

A review of the studies [8] on trans cranial magnetic stimulation in depression summarises that "TMS as a novel antidepressant treatment shows great promise. Systematic and large-scale studies are needed to identify patient populations most likely to benefit and treatment parameters most likely to produce success." Padberg et al [9], treated 37 medication free depressed patients with rTMS. They found significant improvement after ten days of treatment. Shajahan et al [10], in a combined study of rTMS and SPECT, treated patients of depression with rTMS at 80% of motor threshold for a total of 10 days, using 5000 stimuli at 5, 10 or 20 Hz. There were no significant differences in response to treatment as patients in all groups improved. Fitzgerald et al [11], studied 60 depressed patients who had not responded to antidepressants. They were randomised into three groups, one group was given left sided high frequency rTMS, the second group low frequency right sided rTMS and the third group sham TMS. They

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reported treatment with left side high frequency rTMS as ideal in depression, taking into account safety, tolerability and efficacy.

In patients with depression and post traumatic stress disorder 75% of the patients had a clinically significant antidepressant response after rTMS, and 50% had sustained response at two month follow-up. Comparable improvements were seen in anxiety, hostility, and insomnia [12]. In a randomised control trial comparing ECT to rTMS in severely depressed patients, Janicak et al [13] and Grunhaus et al [14] reported similar rates of recovery. Unlike ECT however rTMS causes no neurocognitive deficits. No worsening of performance on any of the cognitive domains over the baseline-post rTMS period was seen when tests were conducted on attention, working memory, executive function, objective memory and motor speed [15]. On the contrary, evidence of modest but statistically significant improvement in performance was seen in working memory, executive function, objective memory and fine motor speed domains over the rTMS treatment period.

rTMS Studies in other Psychiatric Disorders

Grisaru [16] et al, reported significant improvement in 14 manic patients treated with right sided rTMS than with left sided rTMS. Similarly rTMS has been shown to be effective in schizophrenic patients [17]. The study showed that prefrontal rTMS might be effective in the non-pharmacological treatment of psychotic patients. TMS has been shown to reduce auditory hallucinations that are refractory to other treatments. [18]. Twenty-four psychotic patients (schizophrenia and schizoaffective disorder) who had medication-resistant auditory hallucinations randomly treated with rTMS or sham stimulation for 9 days at 90% of motor threshold showed considerable decline in auditory hallucinations with rTMS than to sham stimulation. Frequency and attention salience were the two aspects of hallucinatory experience that showed greatest improvement. Duration of putative treatment effects ranged widely, with 52% of patients maintaining improvement for at least 15 weeks. There are even reports of rTMS improving cognition in patients with schizophrenia possibly by reversing pre frontal hypofrontality. In a trial of twelve schizophrenic patients (eight men, four women) treated with high-frequency rTMS of the dominant dorsolateral prefrontal cortex, performance of the number-connection test which assesses cognitive processes related to the frontal lobe, evaluated before and after rTMS showed significant improvement in women as compared to men thereby indicating its usefulness [19]. rTMS has been reported to be effective in double blind trials in 24 patients of post traumatic stress disorder (PTSD) with regard to the symptoms of re-experiencing and avoidance [20].

High-frequency rTMS over the right dorsolateral prefrontal cortex also alleviated anxiety symptoms. Sachdev et al [21], reported overall significant improvement in obsessions and compulsions in patients with resistant OCD, randomised to receive left or right sided rTMS, there was no difference between the two groups. However another study has not shown improvement in OCD patients after treatment. [22]

In conversion motor disorder i.e. motor paralysis of the left hand a single case report showed that high frequency r-TMS applied to the contra lateral motor cortex produced complete reversal of the symptoms within twelve weeks. [23] The authors postulate that in addition to possible psychological effects, rTMS may have had a causal therapeutic effect by strengthening corticocortical connections and thereby priming voluntary movements.

rTMS has been tried in Tourette disorder without success [24]. Although no trial has been done in ADHD rTMS has been hypothesised to be beneficial. [25]

Conflicts of Interest

None identified

References

1. Barker AT, Jalinous R, Freeston H. Non invasive stimulation of the human motor cortex. *Lancet* 1985;1: 1106-7.
2. Chen R, Classen J, Gerloff C, Celnik P, Wasserman EM, et al. Depression of motor cortex excitability by low-frequency transcranial magnetic stimulation. *Neurology* 1997;48 : 1398-403.
3. Tergau F, Tormos JM, Paulus W. Effects of repetitive transcranial magnetic stimulation on corticospinal and corticocortical excitability. *Neurology* 1997;48: A107.
4. Speer AM, Kimbrell TA, Wasserman EM, et al. Opposite effects of high and low frequency rTMS on regional brain activity in depressed patients. *Biol Psychiatry* 200;48 : 1133-41.
5. Paus T, Jech R, Thompson CJ, Comeau R, Peters T, Evans AC. Dose-dependent reduction of cerebral blood flow during rapid-rate transcranial magnetic stimulation of the human sensorimotor cortex. *J Neurophysiol* 1998; 79:1102-7.
6. Wassermann EM, Kimbrell TA. Local and distant changes in cerebral glucose metabolism during repetitive transcranial magnetic stimulation (rTMS) (abstract). *Neurology* 1997; 48:A107-A108.
7. Fox P, Ingham R, George MS, Mayberg H, Ingham J, Roby J, Martin C, Jerabek P. Imaging human intra-cerebral connectivity by PET during TMS. *Neuroreport* 1997; 8:2787-91.
8. Gershon, AA, Dannon, NP, Grunhaus L. Transcranial Magnetic Stimulation in the Treatment of Depression. *Am J Psychiatry* 2003;160:835-45.
9. Padberg F, di Michele F, Zwanzger P, Romeo E, Bernardi G, Schule C, et al. Plasma concentrations of neuroactive steroids before and after repetitive transcranial magnetic stimulation (rTMS) in major depression. *Neuropsychopharmacology* 2002;27:874-8.

10. Shajahan PM, Glabus MF, Steele JD, Doris AB, Anderson K, Jenkins JA, et al. Left dorso-lateral repetitive transcranial magnetic stimulation affects cortical excitability and functional connectivity, but does not impair cognition in major depression. *Prog Neuropsychopharmacol Biol Psychiatry* 2002;26:945-54.
11. Fitzgerald PB, Brown TL, Marston NA, Daskalakis ZJ, De Castella A, Kulkarni J. Transcranial magnetic stimulation in the treatment of depression: a double-blind, placebo-controlled trial. *Arch Gen Psychiatry* 2003; 60:10028.
12. Rosenberg PB, Mehndiratta RB, Mehndiratta YP, Wamer A, Rosse RB, Balish MJ. Repetitive transcranial magnetic stimulation treatment of comorbid posttraumatic stress disorder and major depression. *Neuropsychiatry Clin Neurosci* 2003;15:243-4.
13. Janicak PG, Dowd SM, Martis B, Alam D, Beedle D, et al. Repetitive transcranial magnetic stimulation versus electroconvulsive therapy for major depression: preliminary results of a randomized trial. *Biol Psychiatry* 2002;15:52 : 1032-3.
14. Grunhaus L, Schreiber S, Dolberg OT, Polak D, Dannon PN. A randomized controlled comparison of electroconvulsive therapy and repetitive transcranial magnetic stimulation in severe and resistant nonpsychotic major depression. *Biol Psychiatry* 2003;53:324-31.
15. Martis B, Alam D, Dowd SM, Hill SK, Sharma RP, Rosen C, et al. Neurocognitive effects of repetitive transcranial magnetic stimulation in severe major depression. *Clin Neurophysiol* 2003;114:1125-32.
16. Grisaru N, Chudakov B, Yaroslavsky Y, Belmaker RH. Transcranial magnetic stimulation in mania: a controlled study. *Am J Psychiatry* 2000;157:835-6.
17. Rollnik JD, Huber TJ, Mogk H, Siggelkow S, Kropp S, Dengler R, et al. High frequency repetitive transcranial magnetic stimulation (rTMS) of the dorsolateral prefrontal cortex in schizophrenic patients. *Neuroreport* 2000;11:4013-5.
18. Hoffman RE, Hawkins KA, Gueorguieva R, Boutros NN, Rachid F, Carroll K, et al. Transcranial magnetic stimulation of left temporoparietal cortex and medication-resistant auditory hallucinations. *Arch Gen Psychiatry* 2003;60:49-56.
19. Huber TJ, Schneider U, Rollnik J. Gender differences in the effect of repetitive transcranial magnetic stimulation in schizophrenia. *Psychiatry Res* 2003;120: 103-5.
20. Cohen H, Kaplan Z, Kotler M, Kouperman I, Moisa R, Grisaru N. Repetitive transcranial magnetic stimulation of the right dorsolateral prefrontal cortex in posttraumatic stress disorder: a double-blind, placebo-controlled study. *Am J Psychiatry* 2004;161:515-24.
21. Sachdev PS, McBride R, Loo CK, Mitchell PB, Malhi GS, Croker VM. Right versus left prefrontal transcranial magnetic stimulation for obsessive-compulsive disorder: a preliminary investigation. *J Clin Psychiatry* 2001; 62:981-4.
22. Alonso P, Pujol J, Cardoner N, Benlloch L, Deus J, Menchon JM, et al. Right prefrontal repetitive transcranial magnetic stimulation in obsessive-compulsive disorder: a double-blind, placebo-controlled study. *Am J Psychiatry* 2001;158:1143-5.
23. Schonfeldt-Lecuona C, Connemann BJ, Spitzer M, Herwig U. Transcranial magnetic stimulation in the reversal of motor conversion disorder. *Psychother Psychosom* 2003;72:286-8.
24. Munchau A, Bloem BR, Thilo KV, Trimble MR, Rothwell JC, Robertson MM. Repetitive transcranial magnetic stimulation for Tourette syndrome. *Neurology* 2002;59:1789-91.
25. Acosta MT, Leon-Sarmiento FE. Repetitive transcranial magnetic stimulation (rTMS): new tool, new therapy and new hope for ADHD. *Curr Med Res Opin* 2003;19:125-30.

CORPS NEWS

The following award winning papers were presented during the 56th AFMRC, held on 6th Feb 2008 at Armed Forces Medical College, Pune:

1. Chief of Army Staff Award-2007

Title: High Altitude: A Hypercoagulable State: Results of a Prospective Cohort Study.

Speaker: Lt Col Jyoti Kotwal, Classified Specialist (Pathology & Haematology), AH (R&R), Delhi Cantt.

2. Chief of Naval Staff Award-2007

Title: Renal Transplantation: An Experience of 500 Patients

Speaker: Col PP Verma, Senior Advisor (Medicine & Nephrology), AH (R&R), Delhi Cantt.

3. Chief of Air Staff Award-2007

Title: Walking Epidural: An Effective Method of Labour Pain Relief.

Speaker: Wg Cdr RM Sharma, Reader (Department of Anaesthesiology), Armed Forces Medical College, Pune.

4. DGAFMS & Senior Colonel Commandant Award-2007

Title: Malaria on the Move: Ecological Considerations for the Armed Forces.

Speaker: Lt Col Pijush Jaiswal, Officer Commanding, SHO (L), Meerut Cantt.

5. Late Lt Gen RS Hoon, PVSM, AVSM Award-2007

Title: Clinical and Angiographic Study of Myocardial Infarction after Battle Physical Efficiency Test in Military Soldiers.

Speaker: Lt Col Harinder Singh, Classified Specialist (Medicine and Cardiology), MH (CTC), Pune.