Bilateral Dorsomedial Prefrontal Cortex rTMS for Tinnitus Treatment: A Successful Case

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ABSTRACT

We present a successful tinnitus treatment case with intensity and distress reduction in a patient subjected to bilateral 10 Hz repetitive transcranial magnetic stimulation (rTMS) to the dorsomedial prefrontal cortex (DMPFC). Subjective tinnitus is the perception of sound in the ears or head when no corresponding external stimulus exists. Approximately 1%–2% of the population report severe tinnitus with daily life impairment. Sham-controlled studies have revealed benefits using rTMS in tinnitus, although the improvement is moderate or temporary, indicating the need for new strategies. Evidence that the DMPFC is important in tinnitus pathophysiology makes this area a promising target. A 51-year-old male patient with a 4-year history of treatment-resistant moderate bilateral tinnitus was treated with 20 sessions of bilateral 10 Hz DMPFC rTMS. The patient showed important reduction and sustained 4-month response in tinnitus loudness and annoyance, 24 point drop in tinnitus handicap inventory, visual analog scale reduction to zero, and tinnitus loudness of 1 dB compared to baseline 15 dB. Tinnitus treatment is challenging and new alternatives are needed. To our knowledge, this is the first report using rTMS to the DMPFC for tinnitus. In this protocol, important and sustained reduction of tinnitus annoyance and loudness was obtained. This outcome of the case suggests that this approach is promising for treating tinnitus and is worth further investigation.

Keywords: Tinnitus, prefrontal cortex, transcranial magnetic stimulation

Introduction

In this report, we describe a successful case with a reduction in tinnitus intensity and distress in a patient subjected to bilateral high frequency repetitive transcranial magnetic stimulation (rTMS) to the dorsomedial prefrontal cortex (DMPFC).

Subjective tinnitus is characterized by the perception of sound in the ears or head when there is no corresponding external stimulus. About 5% to 15% of the adult population perceives these sounds chronically. Approximately 1%–2% of the general population report severe tinnitus associated with an impact on daily life. Despite extensive literature concerning tinnitus treatment, there are still no evidence-based established treatments for curing tinnitus or for effectively reducing its intensity [1].

Some sham-controlled studies have revealed beneficial effects using rTMS in the treatment of tinnitus. Nevertheless, results show only a moderate or temporary improvement and high variability between individuals. New strategies focusing different brain areas related to tinnitus should be tested and evaluated in new studies [2, 3]. The subcallosal area containing the medial prefrontal (dorsal and ventral) and anterior cingulate cortices has been implicated in tinnitus pathophysiology, according to neuroimaging studies, making this area a potential target for tinnitus treatment with rTMS [4, 5]. The use of DMPFC rTMS has been described in the treatment of other disorders and recently it was reported in a series of three cases in patients with major depression in borderline personality disorder, with successful results [6].

Given the scientific background, we experimented a new rTMS protocol with promising results described in this case report.

Case Presentation

The patient provided written informed consent. A 51-year-old Caucasian male, an engineer by profession, presented with continuous, bilateral, symmetric tinnitus for 4 years and was previously treated with pharmacological interventions and tinnitus retraining therapy with no reduction in tinnitus intensity or annoyance. The tinnitus worsened with stress and in a silent environment. The patient had no dizziness, hearing loss, or fulness in the ears. He was healthy, did not use any medication regularly, and had no complaints of pain in the head or neck. An otolaryngological clinical examination and the audiometric and laboratory tests were normal.

The Mini International Neuropsychiatric Interview (MINI) v 5.0 revealed no concomitant psychiatric disorders. The symptom was measured using the Tinnitus Handicap Inventory (THI) and visual analog scale (VAS), tinnitus pitch matching (PM), loudness matching (LM), and minimal masking level (MML) at baseline, 2 weeks, and 1 and 4 months after treatment.

The rTMS protocol consisted of 10 Hz stimulation at 120% of the resting motor threshold of the extensor hallucis longus. Each session of 10 Hz stimulation applied 3000 pulses to each hemisphere non-simultaneous (6000 pulses total), a duty cycle of 5 seconds on and 10 seconds off, for a total stimulation time of 30 minutes, 5 times a week consecutively for 4 weeks over the bilateral DMPFC (Fz electrode site in the 10/20 International EEG system, corresponding to the 25% of the nasion-inion distance), using the fluid-cooled figure-of-eight-coil (Neurosoft, Neuro-MS/D device).

The baseline, 2-weeks, and 1- and 4-month follow-up THI and VAS scores and tinnitus loudness and MML are presented in Table 1. At baseline, the patient had moderate tinnitus, grading 38 in THI and 7 in VAS. After 4 weeks of rTMS, the patient effectively responded to the treatment as indicated by a drop greater than 20 points in the THI, a reduction of VAS to 0, and MML and tinnitus loudness reduction to 1 dB, compared to 18 and 15 dB, respectively, at baseline. There were no reported side effects after rTMS. At 4 months, the patient displayed sustained remission.

Discussion

To our knowledge, this is the first report of the use of rTMS targeting the DMPFC to treat tinnitus. The treatment of tinnitus is notoriously challenging and new alternatives are urgently needed. In our report, the patient showed an important and sustained reduction of his tinnitus after bilateral DMPFC-rTMS. Our findings suggest that rTMS targeting the medial prefrontal cortex, specifically the DMPFC, represents a safe and tolerable therapeutic alternative for tinnitus treatment. Evidence shows that tinnitus patients exhibit significantly less gray matter (GM) volume in the ventromedial prefrontal cortex (VMPFC) well as in the DMPFC compared to control participants [4]. Studies have identified that the GM reductions in the DMPFC correlated directly with the proportion of the time participants were aware of their tinnitus. Thus, patients with bigger cortical sulci were aware of their tinnitus more often than those with DMPFC gyrification like control participants, suggesting that this area plays an important role in tinnitus [5]. In a study using voxel based morphometry, there was evidence of significant volume loss in the subcallosal area (which includes the DMPFC) in tinnitus patients [7]. Thus, the subcallosal area may be considered a major hub linking the limbic-affective systems with the thalamo-cortical system.

The first clinical study with tinnitus patients stimulated in deeper brain areas was published by Vanneste et al. [8] in which double-cone-coil (DCC) rTMS was applied to the medial frontal cortex of 78 patients, which led to improvement depending on the frequency of the stimulation. A second study with 73 patients was published reporting differences between single session and repeated sessions of 1 Hz DCC TMS prefrontal stimulation (anterior cingulate cortex) for tinnitus treatment. Both single sessions and multiple sessions suppressed tinnitus distress and intensity transiently. Multiple sessions generated a higher suppression effect in more patients compared to a single session [9].

A randomized, double-blind pilot trial with 40 patients with chronic tinnitus compared mediofrontal stimulation using DCC (10 Hz) combined with left temporo-parietal stimulation with figure-of-eight-coil (1 Hz) to the left dorsolateral prefrontal cortex stimulation with the figure-of-eight-coil (10 Hz) combined with temporo-parietal stimulation with the figure-of-eight-coil (1 Hz). The combination of mediofrontal/temporoparietal-rTMS failed to show a better outcome when compared to the dorsolateral prefrontal/temporo-parietal group [10].

The impressive results of this case with important and sustained reduction of tinnitus annoyance and loudness in a previously treated patient suggests that rTMS of the DMPFC is a promising approach for the treatment of tinnitus and is worth further investigation. The coil placement is simple and can be accurately achieved without magnetic resonance imaging guidance. Even though the DMPFC is situated 3–4 cm deep, the figure-of-eight coil can stimulate this area when the motor threshold of the extensor hallucis longus is found [11]. Considering the present report, it can now be said that randomized sham-controlled trials to assess the efficacy of DMPFC-rTMS in tinnitus are important and could drastically, safely, and effectively improve patient's condition.

Table 1. Treatment evolution data

	Baseline	2 weeks post	1 month post	4 months post
THI	38	16	14	14
VAS	6	0	0	1
Loudness	18	1	3	4
MML	15	0	3	4

THI: tinnitus handicap inventory; VAS: visual analog scale; MML: minimal masking level.

Informed Consent: Informed consent was obtained from the patients who participated in this study.

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