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Research Article

Pico-Tesla Transcranial Magnetic Stimulation in Cerebral Atrophy Patients

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Abstract

Biomagnetic measurements were performed in our lab using a whole-head 122-channel MEG gradiometer device (Neuromag-122,Neuromag, Ltd. Helsinki, Finland). Recordings were taking in an electromagnetically shielding room in order to avoid extraneous electromagnetic noise. External pico-Tesla transcranial magnetic stimulation (pT-TMS) was applied to 5 male cerebral Atrophy patients with proper characteristics (magnetic field in the order of pT and frequency the alpha rhythm of the patient (8 - 13Hz)). The MEG recordings after the application of the pT-TMS shown a rapid attenuation of the abnormal MEG activity followed by an increase of the low frequency components of the patients. We observed that the results in 4 out of 5 patients were statistically significant (80%). Although our results are very preliminary due to too small study group, we encourage more studies to be conducted.

Keywords: *MEG; Cerebral Atrophy; pT-TMS*

Introduction

Magnetoencephalography (MEG) is considered as non-invasive method for recording the magnetic fields produced by the neuronal brain activity. Professors Anninos and Tsagas [1] invented an electronic device that can increase the (2 - 7 Hz) abnormal MEG brain frequencies towards frequencies of less or equal to their alpha frequencies (8 - 13 Hz). The electronic device consists of one generator that produces low voltage of frequencies from 2 - 7 Hz, and supplies a number of selected coils of one group which consists of alike rows of coils or plurality of groups of similar coils arranged in rows. The pico-Tesla (pT) (1pT = 10^{-12} T)-TMS electronic device is a modified helmet enclosing up to 122 coils that cover the 7 brain regions: Frontal, Vertex, Occipital, Right-left Temporal and Right-left Parietal (Figure 1).

Methods

In our lab, using a whole-head 122 channel gradiometer device(Neuromag-122,Neuromag Ltd, Helsinki, Finland) we performed MEG recordings in a magnetically shielded room for 5 male Atrophy patients with their age ranging from 19 - 25 years [1-5] (Figure 1). Our MEG records were taking with sampling frequency rate of 256 Hz and associated Nyquist frequency of 128 Hz, which was well above the constituent frequency components of interest and avoid aliasing artifacts. The MEG filtered with cut-off frequencies at 0.3 and 40 Hz. The research protocol were approved by the Research Committee of our Democritus University of Thrace. Funding for this work was provided by our collaboration of General Secretariat of Research and Technology, GR and the ERGO AEBE,INC,GR under research program (Grant Number:80623).

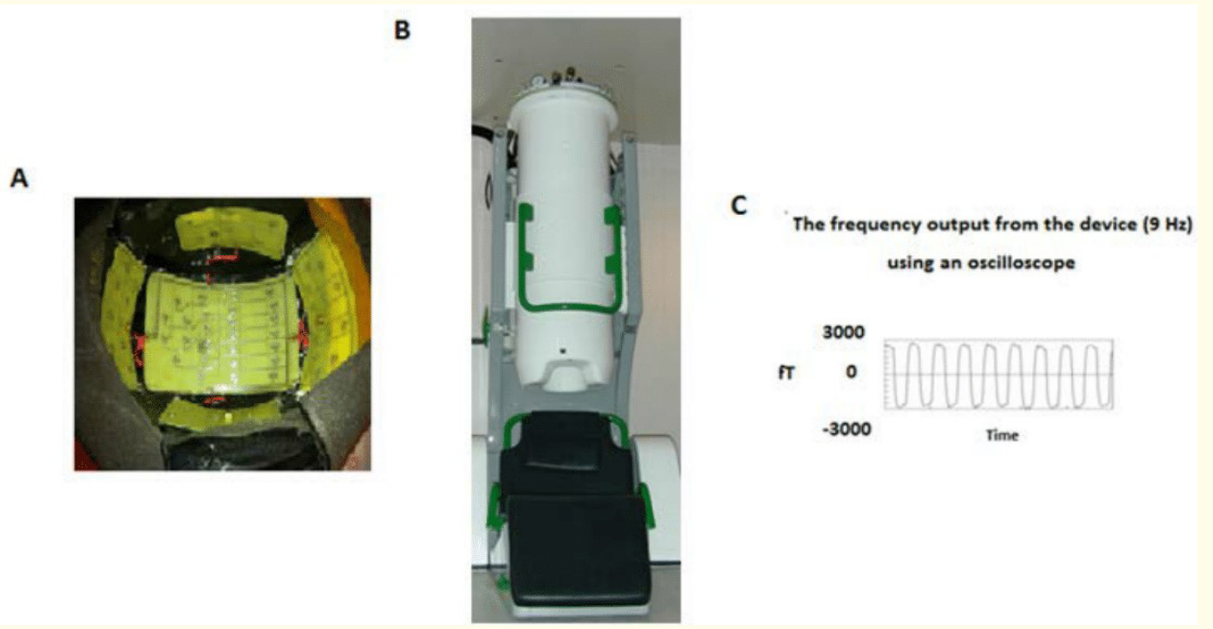

Figure 1: *A). The pT-TMS electronic device, B) The 122 channel MEG system, C) The output of the device.*

A software program was developed in our lab in order to detect the amplitude of the primary dominant frequency of the power spectra of the MEG obtained from each Atrophy patient and channel after the application of Fast Fourier Transform(FFT) (Figure 2). Then we looked for interest at alpha frequency (8 - 13 Hz) for calibration of the electronic device and (2 - 7Hz) for the analysis at the primary dominant frequency of the power spectra of the MEG records obtained from each Atrophy patient and channel after the FFT application.

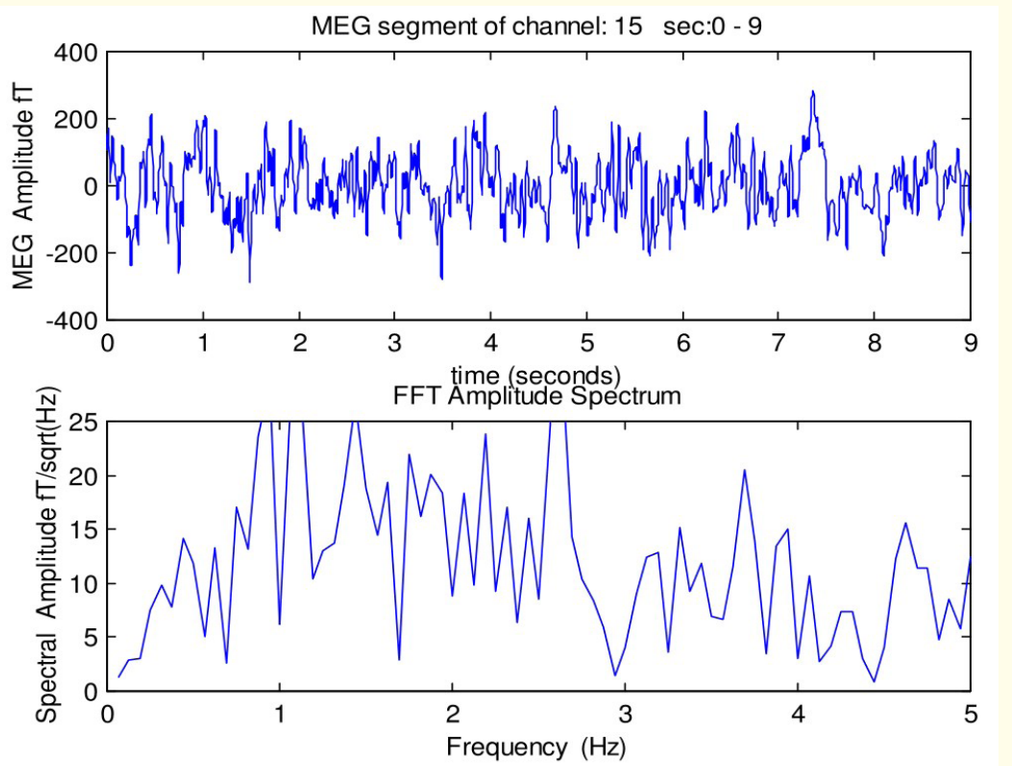

Figure 2: *A) An MEG record of 9 sec obtained from a patient B) the application of FFT on the MEG record we can see that primary dominant frequency is 2.7Hz.*

Every Atrophy patient was scanned in two sessions. The first session consisted of 2-minute resting state MEG scan and the data were used to establish the subject's alpha frequency (8 - 13 Hz) for calibration of the pT-TMS electronic device. The second session consisted of 2-minutes of pT-TMS stimulation. Following these 2-minutes of stimulation, a further 2-minutes of resting state MEG was acquired to Atrophy patients.

Results

Table 1 is shown the brain regions and the corresponding channels in each brain region. In table 2, we can show the true effect of the pT-TMS. In this table we represent the effect before and after stimulation for each of the 5 atrophy patients in each of the 7 brain regions as we have indicated in table 1. Table 3 shows the statistical analysis for the 5 atrophy patients using unpaired t-test. The results were statistically significant at 4 out 5 patients at the level 0.05 (80%).

Brain Regions	Channels
Right Temporal	1-14,111-120
Left Temporal	43-50,55-62,67-74
Right Parietal	5-6,11-16,97-100,109,110,115-122
Left Parietal	47-52,59-64,71-74,79,80,87-90
Frontal	17-42
Occipital	75-86,91-96,101-110
Vertex	13-16,49-54,61-66,73,74,89,90,99,100,117-122

Table 1: *This table shows the brain regions and the corresponding channels in each brain region.*

P	RT BS	RT AS	LT BS	LT AS	RP BS	RP AS	LP BS	LP AS	F BS	F AS	V BS	V AS	O BS	O AS
1	2.44	5.10	2.86	5.31	2.52	5.56	3.06	5.31	2.51	4.81	2.81	5.44	3.00	5.63
2	2.77	4.41	3.16	5.44	3.34	4.41	3.75	4.00	3.18	3.44	3.48	4.41	3.74	3.91
3	2.60	2.00	3.06	2.94	2.69	2.88	3.02	5.63	2.63	3.94	2.90	5.63	2.73	4.13
4	2.58	4.25	2.86	2.38	2.79	4.25	2.87	5.13	2.53	2.88	2.99	4.06	2.38	5.13
5	2.62	5.34	2.45	5.31	2.79	4.50	2.52	3.22	2.40	3.88	2.91	4.50	2.50	5.34

Table 2*: This Table shows the effect before (BS) and after (AS) the pT-TMS for each cerebral Atrophy patient. (P: Patient Number; RT: Right Temporal; LT: Left Temporal; RP: Right Parietal; LP: Left Parietal; F: Frontal, V: Vertex; O: Occipital).*

Patients	BS Mean ± SD	AS Mean ± SD	t-test P values
1	2.74±0.25	5.31±0.28	0.0001
2	3.35±0.35	4..29±0.62	0.0044
3	2.80±0.19	3.88±1.39	0.0657
4	2.71±0.22	4.011±1.05	0.0075
5	2.60±0.19	4.58±0.82	0.0001

Table 3*: Statistical analysis of 5 patients of table 2. The results are statistical significant at the level of 0.05 (marked bold).*

Discussion

In this study was set out to reproduce the effects of the increased abnormal dominant frequencies of 2 - 7 Hz band due to the effect of pT-TMS in cerebral atrophy patients which is a common feature of many of the neurological disorders that affect the brain, like dementia, seizures, language disorders called aphasias [6].

Atrophy of any tissue means a decrement in the size of the cell, which can be due to progressive loss of cytoplasmic proteins. On the other hand in the brain tissue, atrophy describes a loss of neurons and the connections between them. Atrophy can be realized, by the fact that all of the brain has shrunk, or it can be focal, affecting only a limited area of the brain and resulting in a decrease of the functions that area which is control by the brain. If the cerebral hemispheres are affected, then conscious thought and voluntary processes may be impaired. Some degree of cerebral shrinkage occurs natural with age; after the brain completes growth and attains its maximum mass at around age 25 and gradually loses mass with each decade of life [6].

From our experimental design which was based in the pT-TMS we found a significant effect of an increase in their frequencies of the 2 - 7 Hz across the atrophy patients as it is shown in the table 3 in 4 out to 5 patients and the results are statistical significant at the level 0.05 (80%).

One possible electrophysiological explanation for the effectiveness of pT-TMS has been proposed by our "Neural Net Model" [7] that suggests that pT-TMS causes a temporally modulated neuronal inhibition in regions exhibiting abnormal activity in the frequency range of 2 - 7 Hz.

Conclusion

Although our positive results are very preliminary with small number of patients, they encourage more studies to be conducted with larger groups of cerebral atrophy patients.

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