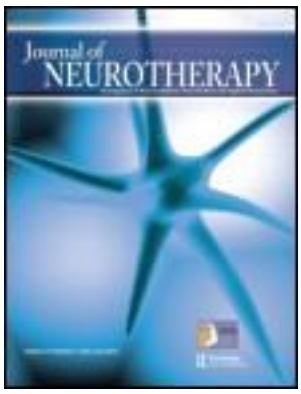

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# The Effect of Neurofield Pulsed EMF on Parkinson's Disease Symptoms and QEEG

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# THE EFFECT OF NEUROFIELD PULSED EMF ON PARKINSON'S DISEASE SYMPTOMS AND QEEG

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**The purpose of this study was to examine the effect of NeuroField pulsed EMF stimulation on Parkinson's Disease (PD) symptoms. Pretreatment, posttreatment, and follow-up QEEG was analyzed along with patient symptom ratings of PD symptoms. The results show significant differences in pre- versus post- versus follow-up QEEG. PD patient symptom ratings were significantly reduced by posttreatment and remained reduced on 30- and 180-day follow-up. NeuroField appears to have potential in reducing PD symptoms.**

## INTRODUCTION

Parkinson's Disease (PD) is a neurodegenerative brain disorder that is estimated to affect 4 to 6 million people around the world and at least 1 million people in the United States alone. It is estimated that 50,000 to 60,000 new PD cases are diagnosed each year. The National Institute of Neurological Disorders and Stroke states that ''PD belongs to a group of conditions called motor system disorders, which are the result of the loss of dopamine-producing cells'' (NINDS, 2012). The four primary symptoms of PD are tremor, or trembling in hands, arms, legs, jaw, and face; rigidity, or stiffness of the limbs and trunk; bradykinesia, or slowness of movement; and postural instability, or impaired balance and coordination. As these symptoms progress, patients may have difficulty walking, talking, or completing simple tasks. The primary treatment of PD is medication that affects dopamine levels in the brain.

The use of repetitive transcranial magnetic stimulation (rTMS) has been shown to be effective in reducing the symptoms of PD (Boylan, Pullman, Lisanby, Spicknall, & Sackeim, 2001; de Groot, Hermann, Steffen, Wagner, & Grahmann, 2001; Dragasevic, Potrebic, Damjanovic, Stefanova, & Kostic, 2002; Fregni, Maia, & Boggio, 2004; Fregni, Santos, et al., 2004; Ikeguchi et al., 2003; Khedr, Farweez, & Islam, 2003; Lefaucheur, 2005; Lefaucheur et al., 2004; Mally, Farkas, Tothfalusi, & Stone, 2004; Okabe, Ugawa, & Kanazawa, 2003; Shimamoto et al., 2001; Siebner, Rossmeier, Mentschel, Peinemann, & Conrad, 2000; Tergau, Wassermann, Paulus, & Ziemann, 1999). An excellent meta-analysis conducted by Fregni, Simon, Wu, and Pascual-Leone (2005) showed that symptoms measured with the Unified Parkinson's Disease Rating Scale were significantly reduced by rTMS above and beyond that of placebo in 12 studies. The studies included in the Fregni et al. (2005) meta-analysis measured the treatment effect through the Unified Parkinson's Disease Rating Scale measurements, psychological testing, subject reports, and visual observations. Effects from rTMS have been shown to be maintained for at least 3 months posttreatment (Fregni et al., 2005). Of the 12 studies in the meta-analysis, none included EEG or QEEG analysis.

The literature suggests that PD symptoms are generated by a dopamine imbalance in the basal ganglia (Boucai, Cerquetti, & Merello,

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2004). Invasive surgical techniques target hyperactive neurons and freeze them, which leads to a drastic reduction in PD symptoms (Boucai et al., 2004). This fast firing rate is hypothesized by the current author to be represented in the EEG by the presence of high beta activity in the 19–30 Hz range. Therefore, the purpose of this study was to investigate whether reducing high beta EEG activity using low-intensity EMF stimulation would lead to a reduction in PD symptoms.

## INSTRUMENTATION

In the case reported here, the NeuroField X2000 and NeuroField Plus coil system was used to deliver EMF stimulation. The X2000 is a four-channel frequency generator that is able to generate pulsed EMF from 0.31–300,000 Hz from 1 to 3 milligauss per pulse. The X2000 also contains two channels of EEG and HRV capabilities. NeuroField Plus is a hardware add-on that connects to the X2000 and increases the EMF output of the device to 1–200 milligauss. The NeuroField Plus device connects to a cable that is attached to four coils that can be placed on the head. The Deymed Truescan 32 EEG was used for QEEG acquisition.

## CASE REPORT METHODOLOGY

A single subject design was created to measure PD symptom increase or reduction of a 53-year-old Caucasian woman who requested NeuroField treatment for PD after being diagnosed more than 2 years ago. Because rTMS has been shown to reduce the symptoms of PD, the author decided to test whether the NeuroField X2000 pulsed EMF (10,000,000 times weaker than rTMS stimulation) would reduce the symptoms of PD. An eyes-open and eyes-closed QEEG was obtained pretreatment, posttreatment, and 30 days after treatment was completed. The NeuroGuide normative database was utilized to analyze the QEEG data. EEG sites for treatment with the NeuroField X-2000 system were selected based on the most deviant high beta z-score absolute power regions as indicated by the QEEG analysis.

The NeuroField Plus coils were placed over P3, P4, and Cz each session. The client was given the 1–100 protocol, which gives sequential EMF pulses for a duration of 1 s each from 1 to 100 Hz. The NeuroField system monitored 4 s of EEG immediately after each pulsed EMF stimulation was given. The NeuroField thresholding system was set to detect decreases in high beta absolute power amplitude. When high beta absolute power decreased more than 50% below the EEG baseline, a ''hit'' would occur, and that frequency that produced the hit would be placed in a ''hit'' table. Those frequencies that caused a reduction of high beta absolute power by 50% were then selected and stimulation was given for 60-s durations at each of those frequencies.

The patient was given a total of 40 treatments, one per day, over a 9-week period. PD symptoms of tremor, rigidity, bradykinesia, and postural instability were rated by the patient at the time of each session and at 30- and 180-day follow-up. Symptom ratings ranged from 0 to 10, with zero indicating no symptoms and 10 indicating the highest severity of the symptom. The null hypothesis would indicate no change in patient symptom rating along with no change in high beta pre-, post-, and follow-up QEEG data.

## RESULTS

The QEEG data were analyzed via the NeuroGuide normative database. Statistical analysis using one-way analysis of variance was conducted using the NeuroGuide statistical software. Significant differences were found for absolute power, relative power, amplitude asymmetry, coherence, and phase lag in both eyes-open and eyes-closed conditions (see Tables 1 & 2). There were no significant differences between pre- and posttreatment high beta absolute power for either condition at sites P3 or P4. However, there was a significant reduction in high beta at Cz for both conditions. Significant differences were found between pretreatment and follow-up eyes-closed conditions for P3

**TABLE 1.** Absolute Power Analysis of Variance (ANOVA) Results for Eyes Open Pre versus Post Condition

| | FFT Absolute Power ANOVA (P-Value) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DELTA | THETA | ALPHA | BETA | HIGH BETA | BETA 1 | BETA 2 | BETA 3 |
| Intrahemispheric: LEFT | | | | | | | | |
| FP1 - LE | 0.435 | 0.917 | 0.326 | 0.000 | 0.000 | 0.016 | 0.000 | 0.000 |
| F3 - LE | 0.034 | 0.101 | 0.862 | 0.054 | 0.139 | 0.442 | 0.559 | 0.036 |
| C3 - LE | 0.011 | 0.559 | 0.300 | 0.840 | 0.261 | 0.446 | 0.591 | 0.334 |
| P3 - LE | 0.037 | 0.773 | 0.473 | 0.384 | 0.587 | 0.798 | 0.804 | 0.051 |
| O1 - LE | 0.005 | 0.165 | 0.709 | 0.220 | 0.807 | 0.727 | 0.880 | 0.016 |
| F7 - LE | 0.000 | 0.000 | 0.002 | 0.019 | 0.602 | 0.156 | 0.007 | 0.352 |
| T3 - LE | 0.004 | 0.019 | 0.974 | 0.020 | 0.262 | 0.514 | 0.908 | 0.031 |
| T5 - LE | 0.095 | 0.448 | 0.893 | 0.149 | 0.788 | 0.792 | 0.973 | 0.010 |
| Intrahemispheric: RIGHT | | | | | | | | |
| FP2 - LE | 0.210 | 0.819 | 0.430 | 0.016 | 0.000 | 0.448 | 0.047 | 0.011 |
| F4- LE | 0.000 | 0.006 | 0.924 | 0.742 | 0.211 | 0.202 | 0.871 | 0.120 |
| 04- LE | 0.025 | 0.321 | 0.053 | 0.180 | 0.956 | 0.013 | 0.095 | 0.830 |
| P4- LE | 0.070 | 0.417 | 0.029 | 0.683 | 0.701 | 0.918 | 0.052 | 0.136 |
| O2 - LE | 0.032 | 0.223 | 0.129 | 0.759 | 0.695 | 0.996 | 0.270 | 0.175 |
| F8 - LE | 0.002 | 0.036 | 0.631 | 0.139 | 0.048 | 0.010 | 0.295 | 0.002 |
| T4- LE | 0.005 | 0.128 | 0.090 | 0.000 | 0.079 | 0.610 | 0.003 | 0.000 |
| T6 - LE | 0.074 | 0.267 | 0.034 | 0.727 | 0.599 | 0.644 | 0.037 | 0.292 |
| Intrahemispheric: CENTER | | | | | | | | |
| Fz- LE | 0.834 | 0.001 | 0.004 | 0.146 | 0.617 | 0.030 | 0.264 | 0.706 |
| Cz- LE | 0.302 | 0.000 | 0.001 | 0.000 | 0.035 | 0.000 | 0.011 | 0.001 |
| Pz- LE | 0.067 | 0.697 | 0.370 | 0.359 | 0.635 | 0.734 | 0.318 | 0.067 |

and P4 but not for Cz high beta absolute power. No significant differences where found for the pretreatment versus follow-up eyes-open condition for P3, P4, or Cz high beta absolute power. However, there were multiple, significant differences at other EEG sites across the

**TABLE 2.** Absolute Power Analysis of Variance (ANOVA) Results for Eyes Closed Pre versus Post Condition

| | FFT Absolute Power ANOVA (P-Value) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DELTA | THETA | ALPHA | BETA | HIGH BETA | BETA 1 | BETA 2 | BETA 3 |
| Intrahemispheric: LEFT | | | | | | | | |
| FP1 - LE | 0.000 | 0.011 | 0.357 | 0.005 | 0.000 | 0.345 | 0.018 | 0.000 |
| F3 - LE | 0.000 | 0.817 | 0.352 | 0.026 | 0.044 | 0.191 | 0.093 | 0.000 |
| C3 - LE | 0.015 | 0.151 | 0.017 | 0.694 | 0.947 | 0.021 | 0.518 | 0.017 |
| P3 - LE | 0.093 | 0.028 | 0.006 | 0.358 | 0.080 | 0.925 | 0.352 | 0.073 |
| O1 - LE | 0.433 | 0.148 | 0.014 | 0.006 | 0.289 | 0.011 | 0.095 | 0.038 |
| F7 - LE | 0.000 | 0.000 | 0.959 | 0.003 | 0.004 | 0.526 | 0.083 | 0.000 |
| T3 - LE | 0.004 | 0.388 | 0.424 | 0.005 | 0.374 | 0.573 | 0.333 | 0.000 |
| T5 - LE | 0.192 | 0.087 | 0.011 | 0.140 | 0.302 | 0.187 | 0.215 | 0.119 |
| Intrahemispheric: RIGHT | | | | | | | | |
| FP2 - LE | 0.000 | 0.000 | 0.952 | 0.010 | 0.043 | 0.960 | 0.004 | 0.022 |
| F4- LE | 0.000 | 0.489 | 0.651 | 0.091 | 0.597 | 0.483 | 0.265 | 0.009 |
| C4- LE | 0.003 | 0.214 | 0.237 | 0.212 | 0.145 | 0.116 | 0.770 | 0.006 |
| P4- LE | 0.057 | 0.273 | 0.024 | 0.059 | 0.138 | 0.903 | 0.106 | 0.016 |
| O2 - LE | 0.664 | 0.435 | 0.015 | 0.014 | 0.226 | 0.127 | 0.027 | 0.058 |
| F8 - LE | 0.000 | 0.080 | 0.409 | 0.007 | 0.008 | 0.126 | 0.039 | 0.010 |
| T4- LE | 0.007 | 0.489 | 0.140 | 0.011 | 0.003 | 0.389 | 0.003 | 0.001 |
| T6 - LE | 0.148 | 0.109 | 0.009 | 0.843 | 0.328 | 0.281 | 0.059 | 0.960 |
| Intrahemispheric: CENTER | | | | | | | | |
| Fz - LE | 0.047 | 0.011 | 0.004 | 0.388 | 0.121 | 0.003 | 0.605 | 0.989 |
| Cz - LE | 0.847 | 0.001 | 0.000 | 0.000 | 0.026 | 0.000 | 0.062 | 0.000 |
| Pz- LE | 0.142 | 0.138 | 0.014 | 0.015 | 0.160 | 0.341 | 0.119 | 0.005 |

**TABLE 3.** Absolute Power Analysis of Variance (ANOVA) Results for Eyes Open Pre versus Follow-Up Condition

| | FFT Absolute Power ANOVA (P-Value) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DELTA | THETA | ALPHA | BETA | HIGH BETA | BETA 1 | BETA 2 | BETA 3 |
| Intrahemispheric: LEFT | | | | | | | | |
| FP1 - LE | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.556 | 0.021 | 0.000 |
| F3 - LE | 0.000 | 0.001 | 0.028 | 0.063 | 0.329 | 0.288 | 0.968 | 0.015 |
| C3 - LE | 0.287 | 0.023 | 0.241 | 0.930 | 0.942 | 0.994 | 0.339 | 0.759 |
| P3 - LE | 0.597 | 0.075 | 0.441 | 0.348 | 0.222 | 0.633 | 0.806 | 0.344 |
| O1 - LE | 0.747 | 0.280 | 0.585 | 0.113 | 0.422 | 0.363 | 0.870 | 0.038 |
| F7 - LE | 0.007 | 0.008 | 0.392 | 0.000 | 0.161 | 0.308 | 0.022 | 0.000 |
| T3 - LE | 0.056 | 0.085 | 0.264 | 0.954 | 0.519 | 0.754 | 0.153 | 0.675 |
| T5 - LE | 0.466 | 0.238 | 0.753 | 0.033 | 0.007 | 0.241 | 0.326 | 0.016 |
| Intrahemispheric: RIGHT | | | | | | | | |
| FP2 - LE | 0.000 | 0.000 | 0.000 | 0.527 | 0.000 | 0.472 | 0.880 | 0.035 |
| F4- LE | 0.000 | 0.000 | 0.000 | 0.000 | 0.576 | 0.001 | 0.001 | 0.349 |
| C4- LE | 0.071 | 0.404 | 0.001 | 0.006 | 0.816 | 0.044 | 0.001 | 0.112 |
| P4- LE | 0.757 | 0.488 | 0.000 | 0.030 | 0.320 | 0.257 | 0.010 | 0.159 |
| O2 - LE | 0.323 | 0.345 | 0.002 | 0.372 | 0.778 | 0.376 | 0.117 | 0.962 |
| F8 - LE | 0.000 | 0.005 | 0.000 | 0.088 | 0.597 | 0.008 | 0.093 | 0.736 |
| T4- LE | 0.046 | 0.571 | 0.000 | 0.821 | 0.505 | 0.012 | 0.686 | 0.071 |
| T6 - LE | 0.063 | 0.291 | 0.000 | 0.013 | 0.360 | 0.043 | 0.014 | 0.279 |
| Intrahemispheric: CENTER | | | | | | | | |
| Fz - LE | 0.000 | 0.000 | 0.000 | 0.699 | 0.494 | 0.392 | 0.077 | 0.131 |
| Cz - LE | 0.000 | 0.000 | 0.000 | 0.000 | 0.207 | 0.001 | 0.000 | 0.003 |
| Pz- LE | 0.875 | 0.285 | 0.156 | 0.686 | 0.464 | 0.602 | 0.169 | 0.615 |

frequency spectrum for absolute power (see Tables 3 & 4). *Z*-score changes were noted in the 19–30 Hz range for both conditions (see Figures 1 & 2). The high beta *z*-score changed from pre- to posttreatment to follow-up QEEG.

**TABLE 4.** Absolute Power Analysis of Variance (ANOVA) Results for Eyes Closed Pre versus Follow-Up Condition

| | FFT Absolute Power ANOVA (P-Value) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DELTA | THETA | ALPHA | BETA | HIGH BETA | BETA 1 | BETA 2 | BETA 3 |
| Intrahemispheric: LEFT | | | | | | | | |
| FP1 - LE | 0.024 | 0.190 | 0.046 | 0.000 | 0.000 | 0.005 | 0.001 | 0.000 |
| F3 - LE | 0.312 | 0.122 | 0.079 | 0.000 | 0.000 | 0.134 | 0.033 | 0.000 |
| C3 - LE | 0.181 | 0.084 | 0.014 | 0.000 | 0.229 | 0.354 | 0.034 | 0.000 |
| P3 - LE | 0.493 | 0.070 | 0.002 | 0.000 | 0.001 | 0.036 | 0.053 | 0.000 |
| O1 - LE | 0.263 | 0.529 | 0.001 | 0.000 | 0.002 | 0.002 | 0.000 | 0.000 |
| F7 - LE | 0.000 | 0.000 | 0.023 | 0.000 | 0.466 | 0.002 | 0.234 | 0.000 |
| T3 - LE | 0.021 | 0.279 | 0.133 | 0.187 | 0.000 | 0.492 | 0.987 | 0.024 |
| T5 - LE | 0.929 | 0.807 | 0.006 | 0.000 | 0.000 | 0.004 | 0.005 | 0.000 |
| Intrahemispheric: RIGHT | | | | | | | | |
| FP2 - LE | 0.146 | 0.003 | 0.006 | 0.000 | 0.000 | 0.010 | 0.000 | 0.000 |
| F4- LE | 0.000 | 0.000 | 0.779 | 0.648 | 0.208 | 0.233 | 0.764 | 0.204 |
| C4- LE | 0.387 | 0.403 | 0.005 | 0.003 | 0.443 | 0.224 | 0.031 | 0.001 |
| P4- LE | 0.281 | 0.956 | 0.001 | 0.000 | 0.000 | 0.008 | 0.007 | 0.000 |
| O2 - LE | 0.156 | 0.364 | 0.001 | 0.000 | 0.002 | 0.009 | 0.000 | 0.000 |
| F8 - LE | 0.481 | 0.666 | 0.273 | 0.919 | 0.079 | 0.791 | 0.947 | 0.915 |
| T4- LE | 0.000 | 0.030 | 0.006 | 0.994 | 0.000 | 0.706 | 0.166 | 0.323 |
| T6 - LE | 0.020 | 0.364 | 0.002 | 0.002 | 0.010 | 0.009 | 0.037 | 0.008 |
| Intrahemispheric: CENTER | | | | | | | | |
| Fz - LE | 0.844 | 0.168 | 0.118 | 0.000 | 0.001 | 0.189 | 0.017 | 0.000 |
| Cz - LE | 0.088 | 0.000 | 0.996 | 0.056 | 0.841 | 0.001 | 0.685 | 0.393 |
| Pz- LE | 0.402 | 0.299 | 0.000 | 0.000 | 0.012 | 0.002 | 0.025 | 0.001 |

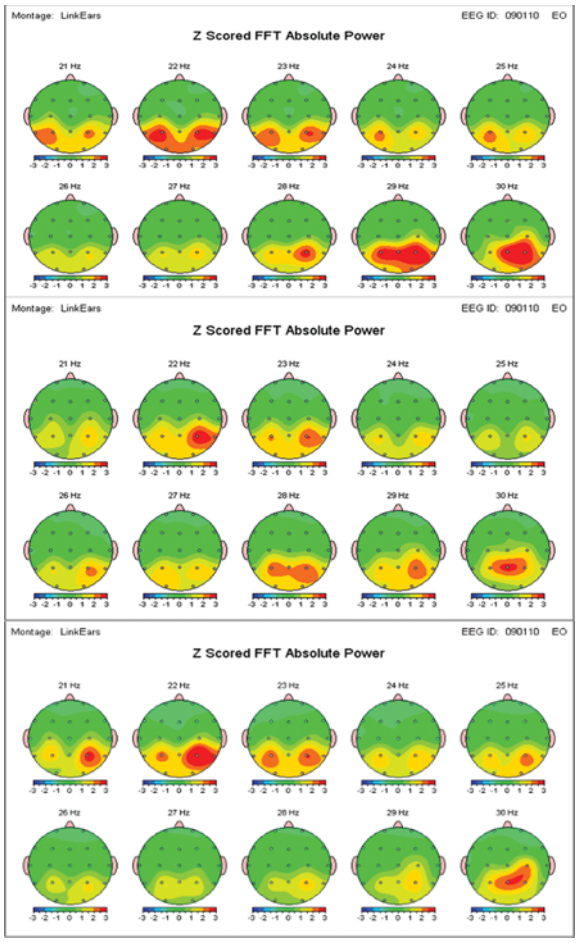


**FIGURE 1.** *Z*-score results for eyes-open pre versus post versus follow-up. (Color figure available online.)

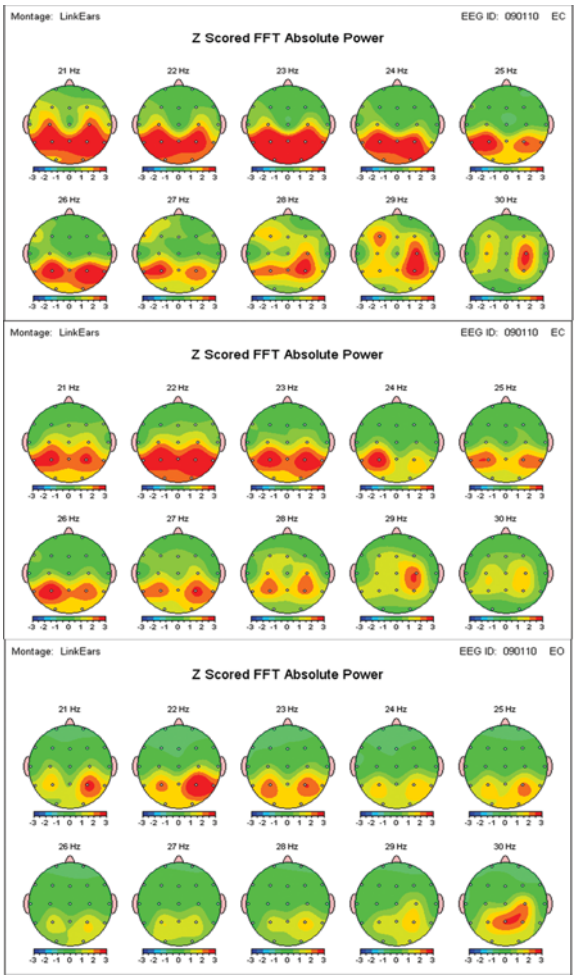


**FIGURE 2.** *Z*-score results for eyes-closed pre versus post versus follow-up. (Color figure available online.)

Symptom ratings all significantly decreased from pretreatment to 30-day follow-up. Tremor reduced from a mean average of 6.7 to 2.1. Rigidity reduced from a mean average of 8.9 to 3.2. Bradykinesia reduced from 8.5 to 1.7, and postural instability declined from 7.3 to 1.4. The patient also reported that she had suffered from insomnia due to strong rigidity effects that caused pain in her arms and legs, but the insomnia issues were no longer present at the end of treatment. Last, she also reported feeling ''clear headed'' by the end of treatment.

Symptom ratings were again assessed 6 months posttreatment. Tremor was rated at a 3, rigidity was rated at 3, bradykinesia was rated at a 2, and postural instability was rated a 2. Unfortunately, QEEG data could not be acquired at the time of follow-up.

## DISCUSSION

The use of the NeuroField low-intensity EMF stimulation appeared to significantly reduce the symptoms associated with PD, which seems to coincide with findings reported from rTMS treatment (Fregni et al., 2005). Six-month symptoms ratings suggest that the treatment effect held over time. No treatment side effects were noted during the course of treatment or at follow-up. QEEGs at pre- versus posttreatment show significant decreases in high beta in the central regions of the brain. Review of the z-score maps ranging from 19–30 Hz indicate that the high beta did change from pre- to posttreatment to follow-up measurements,

suggesting that the brain responded to a low-intensity pulsed EMF treatment.

The use of low-intensity pulsed EMF to reduce the symptoms of PD appears to present a safe potential option for clinical use. This study is limited by being a case report with the lack of a control condition or placebo control. Future research in this area should focus on larger sample size along with the inclusion of a control group. The use of the Unified Parkinson's Disease Rating Scale would also have the potential to more objectively and effectively measure PD symptom responses than the method used in this study.

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