Extended Abstract
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Parkinson's Congress 2019: Electromagnetic Treatment to Old Alzheimer's Mice Reverses β-Amyloid Deposition, Modifies Cerebral Blood Flow, and Provides Selected Cognitive Benefit- Takashi Mori - University of South Florida

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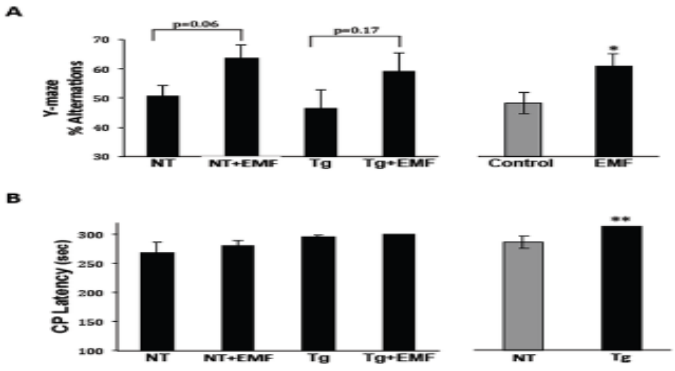
Abstract

Few studies have investigated physiologic and cognitive effects of "long-term" electromagnetic field (EMF) exposure in humans or animals. Our recent studies have provided initial insight into the long-term impact of adulthood EMF exposure (GSM, pulsed/modulated, 918 MHz, 0.25–1.05 W/kg) by showing 6+ months of daily EMF treatment protects against or reverses cognitive impairment in Alzheimer's transgenic (Tg) mice, while even having cognitive benefit to normal mice. Mechanistically, EMF-induced cognitive benefits involve suppression of brain β-amyloid (Aβ) aggregation/deposition in Tg mice and brain mitochondrial enhancement in both Tg and normal mice. The present study extends this work by showing that daily EMF treatment given to very old (21–27 month) Tg mice over a 2-month period reverses their very advanced brain Aβ aggregation/deposition. These very old Tg mice and their normal littermates together showed an increase generally memory function in the Y-maze task, although not in additional complex tasks. Measurement of both body and brain temperature at intervals during the 2-month EMF treatment, also a separate group of Tg mice during a 12-day treatment period, revealed no appreciable increases in brain temperature (and no/slight increases in body temperature) during EMF "ON" periods. Thus, the neuropathologic/cognitive benefits of EMF treatment occur without brain hyperthermia. Finally, regional cerebral blood flow in cortex determined to be reduced in both Tg and normal mice after 2 months of EMF treatment, most likely through cerebrovascular constriction induced by freed/disaggregated Aβ (Tg mice) and slight body hyperthermia during "ON" periods. These results demonstrate that long-term EMF treatment can provide general cognitive benefit to very old Alzheimer's Tg mice and normal mice, similarly reversal of advanced Aβ neuropathology in Tg mice without brain heating. Results further underscore the potential for EMF treatment against AD.

Results:

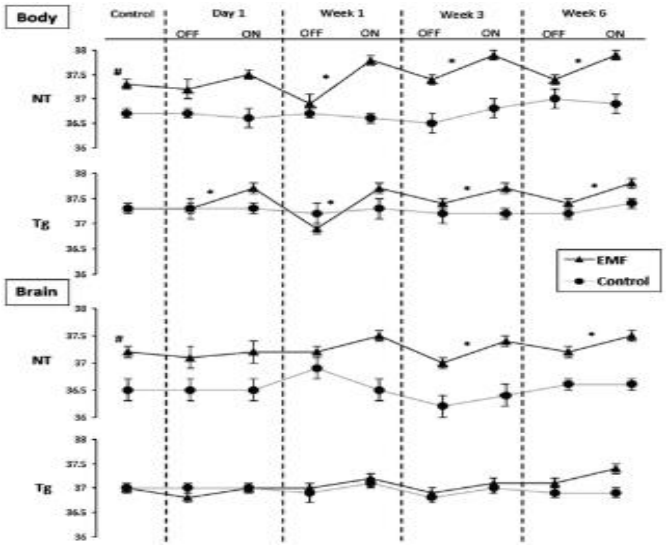
Behavioral assessment during long-term EMF treatment: In Study I, behavioral testing of aged Tg and NT mice between 1 and 2 months into daily EMF treatment indicated no deleterious effects of EMF treatment on sensorimotor function (Table 1). For both Tg and NT mice, general activity/exploratory behavior was unaffected by EMF treatment, as indexed by open field activity and Y-maze choices made. As well, balance and agility abilities weren't impacted in either Tg or NT mice by EMF treatment, as indexed by balance beam and string agility performance. In both of these tasks, however, an overall effect of genotype was presence, with Tg mice having poorer balance/agility compared to NT mice irrespective of EMF treatment ($p<0.002$). Finally, visual acuity testing in the visual cliff task at the end of behavioral testing (2 months into EMF treatment) indicated no deleterious effects of EMF treatment on vision in either Tg or NT mice.



Body/brain temperature recording during long-term EMF treatment:

Study: Body and brain temperature measurements were attained from aged animals in Study I before start of EMF treatment (control) and at 1, 3, and 6 weeks into treatment

(final temperature measurements were unfortunately not taken at the 2-month termination point of this study). Throughout the 6-week study period, body and brain temperature recordings indicated very stable temperature in control NT and control APPsw (Tg) mice not being given EMF treatment .By contrast, body temperature for both EMF-treated NT and Tg mice was modestly elevated by 0.5–0.9°C during ON periods compared to OFF periods, from 1 week into EMF treatment onward through treatment. For Tg mice, this increase in body temperature during ON periods was evident even on the first day of EMF treatment. During EMF OFF periods for both NT and Tg mice, body temperature always came back down to their pre-treatment levels. Since body temperature before start of EMF treatment was identical for Tg mice (but not NT mice) to be given EMF or sham treatment, temperature comparisons between these two groups throughout the EMF treatment period also revealed that the elevated body temperatures of Tg mice during ON periods always came back down to sham control levels during OFF periods.



Discussion: We have previously reported that long-term (>6 months) EMF exposure at cell phone level frequencies and SAR levels can protect against or reverse cognitive impairment in Alzheimer's Tg mice, while even having cognitive benefit to normal mice. Moreover, we previously provided the first mechanistic insight into long-term EMF treatment by reporting the ability of such treatment to suppress brain Aβ aggregation/deposition in AD mice, while enhancing brain mitochondrial function and neuronal activity in both Tg and normal mice .The present study extends the above works by administering long-term (2 months) of daily EMF treatment to very old Alzheimer's Tg mice and showing that such treatment can reverse their very advanced brain Aβ aggregation/deposition while providing selected cognitive benefit to both Tg and normal mice. Moreover, these neuropathologic and cognitive benefits occurred without appreciable increases in brain temperature, indicating involvement of non-thermal brain mechanisms (i.e., Aβ anti-aggregation, mitochondrial enhancement, neuronal activity). Finally, the present study is the first to determine the effects of long-term EMF exposure on rCBF, and in the same animals evaluated for cognitive, neuropathologic, and body/brain temperature endpoints. Our finding of an EMF-induced decrease in cortical blood flow raises several interesting mechanisms of action that merit consideration.

Statistical Analysis: Data analysis of physiologic and neurohistologic measurements, as well as all one-day behavioral measures, were performed using ANOVA followed by Fisher's LSD post hoc test. For the multiple-day behavioral tasks (RAWM and circular platform), initial ANOVA analysis of 2-day blocks and overall were followed by analysis of post hoc pair-by-pair differences between groups via the Fisher LSD test. For temperature and blood flow measurements within the same animal, paired t-tests were employed. All data are presented as mean ± SEM, with significant group differences being designated by $p<0.05$ or higher level of significance.

Note: This work is partly presented at 5th Global Experts Meeting on Parkinsons, Huntingtons & Movement Disorders Oct 30-31, 2019 Tokyo, Japan