PULSED MAGNETIC FIELD INDUCED ANALGESIA: A STUDY OF ELECTRIC CURRENT INDUCED PAIN IN NORMAL SUBJECTS.

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ABSTRACT

The observation that non-specific earth-strength extremely low frequency (ELF) magnetic fields (MF) can attenuate opioid-induced analgesia has been, with the exception of orientation and navigation effects, perhaps the most reliable and reproducible MF effect yet reported. Here we examined the effectiveness of a weak (±200μT) specific pulsed ELF magnetic field, capable of inducing analgesia-like behaviour in animals to induce analgesia in normal human subjects in which an aversive electric current was used to induce acute pain.

INTRODUCTION

The observation that non-specific earth-strength extremely low frequency (ELF) magnetic fields (MF) can attenuate opioid-induced analgesia has been, with the exception of orientation and navigation effects, perhaps the most reliable and reproducible MF effect yet reported [1]. This study examined the effectiveness of a specific pulsed magnetic field, capable of inducing analgesia-like behaviour in animals [2-5] to induce analgesia in normal subjects in which an electric current was used to induce acute pain.

METHODS

Ethics approval for this double blind study was granted by the University of Western Ontario's Review Board for Health Sciences Research involving Human Subjects. Twelve male and female university students were divided into two equal experiment groups with one group exposed to a pulsed magnetic field previously demonstrated in animals to induce analgesia like behaviours [2] ("Analgesia MF") and the other group was exposed to a pulsed magnetic field previously shown to alter balance in humans [6] ("Postural Sway MF"). Subjects were seated in a comfortable chair mounted within a three-axis orthogonal 2m diameter Helmholtz coil array [7] such that their heads were centred within the most uniform portion of the exposure system. Each subject was exposed to a single exposure condition per session, with subjects returning for the remaining exposure condition within a one week period. Both experimenters and subjects were kept blind to the exposure conditions until the completion of the study (double-blinded). The initial exposure condition (i.e. sham or pulsed magnetic field exposed) was randomly assigned but balanced across the study to remove selection bias. Subjects reported the level of induced discomfort/pain using a standardized protocol [8] by completing a visual analogue scale [9] before (0-15 min.) and during (15-60 min.) the application of the pulsed magnetic fields. The electric current was applied to the web of the thumb and forefinger and was ramped every 5 minutes from "not-perceivable" to "unbearable". Electric current (in mA) recordings reported as "moderate" pain were normalized to current values taken at baseline, i.e. average of values at 0 and 15 minutes time points, at 25, 35, 45, 55 and 60 min. A ratio greater than 1 could be interpreted as an induction of analgesia, and less than 1, an increase in sensitivity to electric shock induced acute pain.

RESULTS

In the Analgesia MF exposed group the ratio of electric current increased monotonically from 15 to 60 minutes whereas no effect was observed in the sham control. In the Postural Sway MF exposed group the ratio did not increase in the

exposed group but was reduced at the 35 min. time point. The results show a significant interaction between MF type (analgesia vs. postural sway, see Fig. 1) and exposure condition (sham vs. MF exposed) [$F_{(1,9)}$=8.9, p<0.05, Eta^2=0.64].

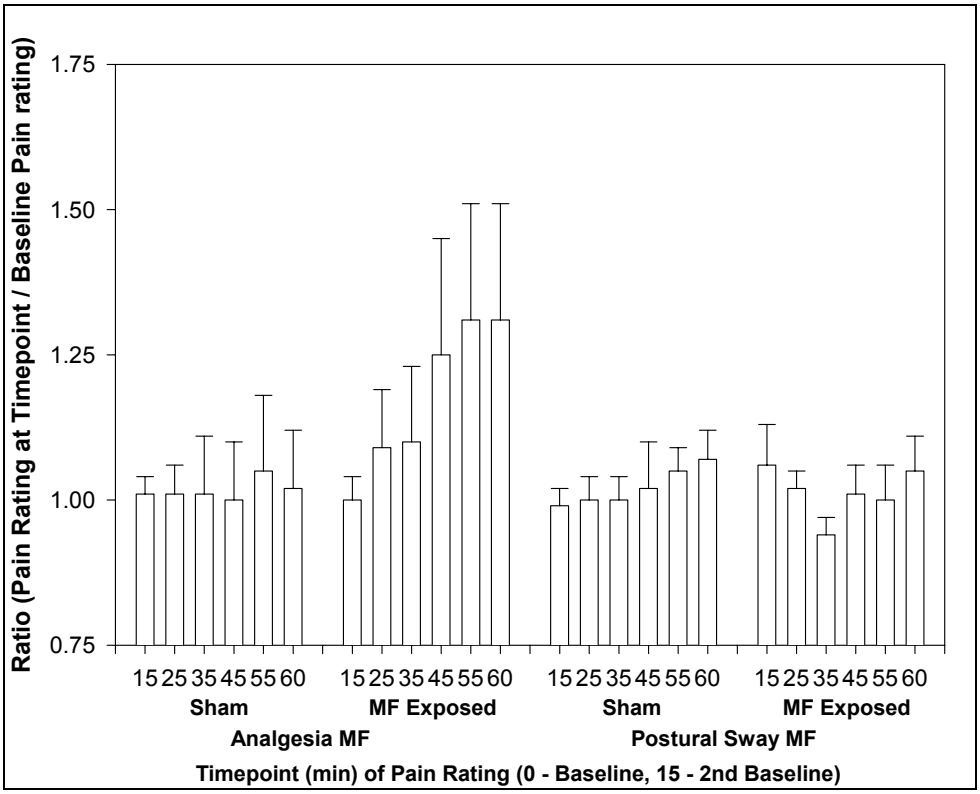

Fig. 1. Ratio of electrical current (mA time point / mA baseline) applied to the web of the left thumb required to produce a subjective 'moderate' pain rating in male and female university students (N=12) while exposed to either a sham or pulsed magnetic field. A ratio greater than 1 could be interpreted as an induction of analgesia (or hypoalgesia), and less than 1, hyperalgesia. Individual subjects were randomly assigned to either an analgesia-inducing MF exposure group (N=6), or postural sway altering MF group (N=6). Sham and MF exposure trials were held at least 1 week apart, and both experimenter and subjects were kept blind to the exposure conditions until the completion of the study (double-blinded). Electric current recordings at each time point (15-60 min) were divided by the averaged baseline readings taken at time point 0 (not shown) and 15. Time point 15 was a second control time point, with exposures (sham or MF) starting at time point 25. The results show a significant interaction between MF type (analgesia vs. postural sway) and exposure condition (sham vs. MF exposed) [$F_{1,9}$=8.9, P = 0.03, Eta^2=0.64]. Note: this is preliminary data and should not be construed as conclusive evidence of the MF induction of hypo- or hyperalgesia. Error bars represent the S.E.M.

DISCUSSION

This is preliminary data and should not be construed as conclusive evidence of the MF induction of hypo - or hyperalgesia. The electric shock-induced pain simulation method has numerous drawbacks including gender differences, high variance, and low ethological validity [10]. Hot/cold pain is an alternate method to electrical pain stimuli in that, it is an ethologically relevant human pain, produces far less gender difference and less variability [11]. Hence we plan to further test the effectiveness of pulsed magnetic fields to induce analgesia in acute pain by subjecting normal subjects to hot/cold pain stimuli.

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