Acute impact of time-varying magnetic fields on human postural control: pilot results and future developments

A Allen, S Villard, M Corbacio, D Goulet, M Plante, M Souques, F Deschamps, G Ostiguy, J Lambrozo, A W Thomas, and A Legros

Introduction

Power frequency magnetic fields (MF – 50 and 60Hz) result from electricity generation and distribution and from the use of electrical household appliances (Gauger, 1985; Gandhi et al., 2001). Recent studies have shown that extremely low frequency (ELF, <300Hz) MF can modulate standing balance (Legros et al, 2012; Thomas et al., 2001; van Nierop et al., 2013). It is possible that MF-induced currents in the vestibular system cause these effects (Glover et al., 2007). However, the thresholds for acute postural control MF effects are yet to be determined. This pilot study explores the acute effects of MF-induced fields and currents and directly applied alternating current (AC) exposure on human standing balance. The study uses direct current (DC) stimulation, also known as galvanic vestibular stimulation (GVS), as a positive control. This work will be used in future protocols to further explore MF exposure thresholds for inducing acute standing balance modulation at varying frequencies.

Hypothesis

Well-established acute standing balance effects in response to GVS (1mA) have been reviewed (Fitzpatrick and Day, 2004). Based on these results, an AC stimulation given at the same intensity as GVS should have a similar effect. In addition, since a 60Hz MF stimulation delivered at 100mT is estimated to induce electric fields and currents equivalent to a 1mA GVS exposure (Merlet et al., 2013; Salvador et al., 2012), it should acutely impact standing balance in a similar fashion.

Materials and Methods

This pilot project has tested six subjects under different MF and electrical stimulation conditions. MF, DC, and AC exposures were delivered at the mastoid (5 seconds per exposure, 1mA for DC and AC exposure, 100mT for MF exposure) at randomized frequencies (DC, 20, 60, 90, 120, and 150Hz). The displacement of the center of pressure was recorded with a force platform (OR6-7-1000, AMTI, USA) and analyzed offline. We aim to test an additional ten participants using a newly developed MF exposure system allowing for free movement, as opposed to the current, fixed MF exposure device.

Results

Based on preliminary inspection of pilot data, DC stimulation seemed to affect sway patterns and demonstrated a clear responsive tilt towards the stimulation anode side of the head. Similar acute effects appear to result from AC exposure to a lesser extent. The MF condition (tested at a single flux density of 100mT) showed minimal effects on standing balance. This was expected since the pilot exposure device was stationary and therefore could not allow for participant movement. The use of a

newly developed ambulatory exposure device should improve this result. Further pilot data collected using this new exposure system will be presented at the conference.

Discussion and Conclusions

This pilot study explored the effects of MF and AC exposure on human standing balance at different frequencies. So far, with six pilot subjects tested, data appears to be promising in demonstrating an acute effect of DC and AC on human standing balance. An additional ten subjects will be tested with a newly developed free-moving exposure device, which will further explore the acute MF effects on standing balance. This preliminary work will contribute to future work seeking to establish thresholds for acute effects of MF exposure and electrical stimulation on standing balance. Knowledge of these thresholds is central to international recommendations for electromagnetic field exposure.