Plugged in and switched on. The effect of acute transcranial direct cortical stimulation on brain metabolites in healthy controls

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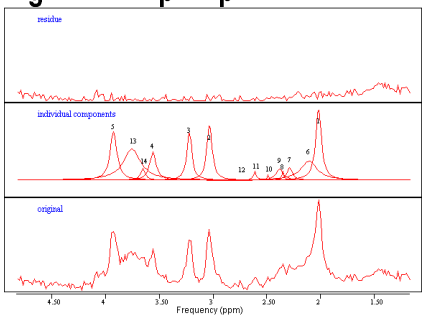
Introduction

Transcranial direct cortical stimulation (DCS) is a novel treatment for depression, and may work by altering brain activity [1]. A related technique, transcranial magnetic stimulation (TMS) has previously been shown to alter brain glutamate levels [2] suggesting a possible mechanism by which DCS may act. Here, we conducted a trial of DCS in healthy young controls to determine the timecourse of changes, if any, in brain metabolite levels.

Methods

We studied 10 healthy young male controls (range 22 - 27 y) using a blinded, pseudo-randomised, cross-over design. All MR was acquired at 3T using a Philips Achieva system. Prior to treatment, we obtained three measurements of baseline MRS from the left dorsolateral prefrontal lobe (DLPFC) using a 2x2x2 cm VOI and the PRESS sequence (TE = 31 ms, TR = 2 s), along with a spectrum of the unsuppressed water signal using an eight channel SENSE headcoil. Subjects were then removed from the magnet and received either 20 min DCS treatment (2 mA), or sham control (< 30 s DCS). Subjects quickly reentered the magnet. The Philips SmartScan protocol was used to reposition the VOI. A timecourse of six spectra were acquired over the next hour. Spectra were processed using jMRUI (v 2.x) using the AMARES algorithm and soft constraints (linewidth and shift) as prior inputs (Fig. 1).

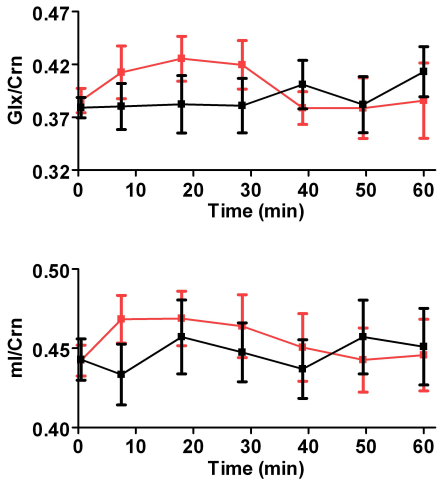
Fig. 1. Example spectrum and fit



Results

The timecourse of Glx/Crn and mI/Crn can be seen in Fig. 2. There were significant changes in the ratio of Glx to creatine (N-methyl) over time (ANOVA) with the increase in Glx lasting 30 min before declining rapidly to baseline levels compared to sham. An increase in *myo*inositol was also seen which declined more slowly. There were no significant changes in any other ratio (NA, Cho or Cre to H_2O or to total signal).

Fig.2. DLPFC metabolites following DCS (red) or sham (black). (N = 10)



Discussion

This study shows acute, significant changes in the level of Glx (mostly glutamate with a contribution from glutamine) with time following DCS and slightly less marked relative increases in *myo*inositol, indicative of increased metabolic work in the DLPFC. This indicates that DCS induces not just changes in blood flow but also induces changes in brain activity. A previous report has shown elevated mI in a single time point experiment obtained 30 min after DCS but no change in Glx [3]. This timecourse indicates the importance of early measurement to detect metabolic changes following a single DCS treatment.

References

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