Avoiding skin burns with transcranial direct current stimulation: preliminary considerations

Received 27 June 2010; Reviewed 9 July 2010; Revised 6 August 2010; Accepted 2 September 2010; First published online 6 October 2010

Interest is rapidly developing in transcranial direct current stimulation (tDCS) as an emerging tool in neurology and psychiatry. tDCS involves the application of weak, unidirectional currents through scalp electrodes to alter neuronal excitability, that may outlast the period of stimulation (Arul-Anandam & Loo, 2009). In addition to being a tool for neurophysiological investigations, tDCS has been examined as a treatment for many neuropsychiatric disorders (Nitsche et al., 2008), in particular depression (Boggio et al., 2008; Fregni et al., 2006; Loo et al., 2010).

Clinical application of tDCS in neuropsychiatric disorders often involves repeated stimulation sessions, typically on consecutive days, in an attempt to create robust and lasting changes in neuronal functioning. Stimulation parameters (current intensity, stimulation duration, etc.) have been gradually adjusted to optimize therapeutic effects (Arul-Anandam & Loo, 2009). Skin burns have recently been reported in treatment trials of tDCS in depression involving multiple stimulation sessions given at the upper range of stimulation parameters, and when applied repeatedly to the same scalp sites (Frank et al., 2010; Palm et al., 2008). Other researchers have provided guidance on safety issues in tDCS technique (Nitsche et al., 2008), but we report here on an aspect which has not previously been addressed in the tDCS literature.

Prior to commencing our first clinical trial, we piloted tDCS technique on the skin of the dorsal forearm in a volunteer subject (1 mA, 20 min, two 7 × 5 cm rubber electrodes). The initial test led to skin burns under the anode, associated with pain at the stimulation site, and was attributed to the drying out of the conductive gel used (Lagopoulos & Debabriele, 2008).

We repeated the trial with saline-soaked sponges placed under the electrodes, ensuring that the sponges remained moist. Again, stimulation was painful and was stopped, due to concerns that this was an antecedent to developing skin burns. For both trials, the skin had been abraded vigorously with a gauze swab prior to the application of electrodes to reduce impedance. We hypothesized that uneven abraction of skin layers was responsible for the small dot-shaped burns which occurred around sweat glands, as the skin around the opening of the glands is slightly raised. As a result, this could have caused focal excesses in current density leading to the observed skin burns.

Subsequent trials in which we avoided abrading the skin resulted in stimulation without any skin damage. We have since given over 2000 stimulation sessions of tDCS to the forehead (1–2 mA intensity, 20 min duration), including 10–30 repeated stimulations on consecutive weekdays to the same scalp sites in over 90 subjects, without any skin damage using an Eldith DC Stimulator (NeuroConn GmbH, Germany) with 7 × 5 cm rubber electrodes supplied by the manufacturer. We think it prudent to ask the subject to report if stimulation is painful, as this may be an early indication that skin damage is starting to occur, although the absence of pain does not indicate safe stimulation, just as pain does not necessarily indicate that skin damage is occurring, but may reflect current-induced activation of skin receptors.

The stimulation procedure we developed at our centre is summarized here:

**tDCS stimulation procedure**

1. Subjects are initially screened for skin diseases and use of any skin treatments which could potentially cause irritation.
2. Before every tDCS session, skin under the electrodes is checked for cuts, lesions, and skin disease. tDCS is not given if there is any skin damage, rash or other skin lesion under the electrode sites.
3. Skin is lightly cleaned with a swab, taking care not to abrade the skin.
4. Disinfected rubber electrodes with clean, single-use sponges dampened with normal saline are placed over the stimulation sites and held against the head with wide rubber bands which cover the entire surface of the electrodes. Care is taken to ensure contact with the skin is firm and even over the entire surface of the electrode.
The static impedance measurement is checked – stimulation does not proceed unless levels are within limits recommended by the tDCS device manufacturer.

Stimulation is commenced and subjects are advised to report immediately if the stimulation feels painful, or anything other than itchy or tingling, at any time during the period of stimulation.

After the first 2 min, the subject is questioned about pain at the electrode sites. If the stimulation is painful, a small amount of additional saline (approximately 4 ml) is added to the sponge, taking care to avoid wetting adjacent hair and thereby increasing the electrode area, and the tightness and placement of the band are checked. If pain persists, the stimulation is stopped and the electrode sites checked. This procedure is repeated every 10 min during tDCS with a small amount of saline solution being routinely applied at these times.

At the end of stimulation, the electrode site is checked for redness or skin damage.

Rubber electrodes and headbands are cleaned with a disinfectant solution.

We have found that adding saline usually reduces any pain experienced and it is rarely necessary to cease stimulation mid session, resulting in an interruption that may modify the effects of tDCS. In summary, two important observations arose from our piloting of tDCS technique: (1) abrasion of the skin increases the risk of skin burns. This is relevant to other stimulation techniques, e.g. electroconvulsive therapy. (2) Skin burns are usually preceded by pain, therefore asking the subject to report any pain during the stimulation procedure is a useful precaution.

Acknowledgements

None.

Statement of Interest:

In the last 3 years, Dr Mitchell has reported receipt of remuneration for: lectures from AstraZeneca and Eli Lilly; consultancies from Eli Lilly and Janssen-Cilag; advisory board membership from AstraZeneca; and medico-legal reports from the Australian Therapeutic Goods Administration, Eli Lilly and Alphapharm.

References


C. K. Loo1,2,3, D. M. Martin4, A. Alonzo5, S. Gandevia6, P. B. Mitchell1,2, P. Sachdev4,5

1 School of Psychiatry, University of New South Wales, Sydney, Australia
2 St George Hospital, Sydney, Australia
3 Black Dog Institute, Sydney, Australia
4 University of New South Wales and Prince of Wales Medical Research Institute, Australia
5 Neuropsychiatric Institute, Prince of Wales Hospital, Sydney, Australia