Brain Stimulation (2008) 1, 386–7

ELSEVIER

BRAIN
STIMULATION

www.brainstimjrnl.com

LETTER TO THE EDITOR

Skin lesions after treatment with transcranial direct current stimulation (tDCS)

To the Editor: Transcranial direct current stimulation (tDCS) of the brain has been recently proposed as therapeutic intervention in a variety of neurologic and psychiatric disorders. Pilot studies by Fregni et al,[1] Boggio et al,[2] and Rigonatti et al[3] found an improvement of depressive symptoms in drug-naïve patients suffering from major depression; however, replication trials are needed. Generally, adverse effects were reported to be rare and mild, including headache and skin erythema under the sponge electrodes. Moreover, the safety guidelines of Nitsche et al[4] and Iyer et al[5] did not mention any severe adverse effect of tDCS.

Here we report five cases of skin lesions after treatment with tDCS. In a pilot study on depressed patients, 10 patients underwent 1 mA tDCS and 5 patients underwent 2 mA tDCS. Each active tDCS was applied over 20 minutes (15-second ramp in and ramp out each) on 5 days per week during a 2-week period. For stimulation a CE-certified Eldith DC-stimulator (Neuroconn, Ilmenau, Germany) with two water-soaked sponge electrodes (7 × 5 cm, 35 cm^2) was used. Water-soaked sponges were used because they cause less uncomfortable itching sensations applied than saline-soaked sponges[6] and allow EEG recording immediately after tDCS, which was an adjunctive investigation in this study. The anode was placed over the left dorsolateral prefrontal cortex (DLPFC) with the center over F3 (10-20 system) and the cathode over the right supraorbital region as previously reported.[1]

In the group receiving 1 mA stimulation, all patients showed a mild redness of the skin under the cathode, but not under the anode immediately after tDCS, which disappeared after a few minutes. Only one patient with generally irritable skin showed a small skin lesion with larger erythema and small brown crusts occurring after 4 days of tDCS that persisted until the end of tDCS treatment. In contrast, similar skin lesions were observed in all five patients undergoing 2 mA tDCS so far. The lesions showed extensive redness and brown crusty intracutaneous changes with irregular but overall round shapes (Figure 1). The extension of the lesions ranged from 2-3 mm up to 2 cm and was proportional to the skin impedance measured while connecting the DC-stimulator. Four patients with small lesions had an initial skin impedance of 30-35 kΩ and one patient with a 2 cm lesion showed skin impedances of 50-55 kΩ prior to tDCS. The impedence decreased during ramp up, and were kept constantly below 20 kΩ for the stimulation period controlled by the stimulator. Generally, these lesions occurred after the fourth or fifth DC-stimulation, showed stable superficial extensions during further tDCS, and healed without scars about 1-3 weeks after the end of tDCS treatment. To avoid superinfection, sponge foams were carefully disinfected or replaced. The general appearance of the lesions was neither characteristic for burns nor for lesions induced by scratching and superinfection. None of the subjects in the 2 mA group previously had a particularly irritable skin.

To our knowledge, such lesions have not been published for tDCS so far and may be more likely to occur while stimulating at higher intensities for a longer period as in our subjects receiving 2 mA five times a week for 2 weeks. Thus, we regard DC-stimulation as the primary cause and consider a change of the dermal equilibrium by DC-iontophoresis under the supraorbital cathode. The direction of DC from cathode to anode would explain the skin heating and erythema that we found under the cathode in all cases but never under the anode. Alternatively, it may be possible that thermal properties of cathodal DC may have caused a mild skin burn with consecutive superinfection particularly when the electrode gets dryer and the conducting surface may be reduced. The high skin impedance in the subject with the largest lesion may suggest the latter. Moreover, there was a clear relationship between the intensity of DC and skin lesions in all 15 patients and a delay between the first DC treatment and the appearance of lesions after 4-5 tDCS sessions. It is surprising that this side effect has not been reported previously; however, the occurrence of lesions may depend on the intensity and duration of tDCS as well as on the impedance between electrode and skin. In the latter respect, the use of tap water instead of sodium chloride solution in the current study may have led to higher impedance and pronounced thermal side effects.

1935-861X/08/$ -see front matter
doi:10.1016/j.brs.2008.04.003

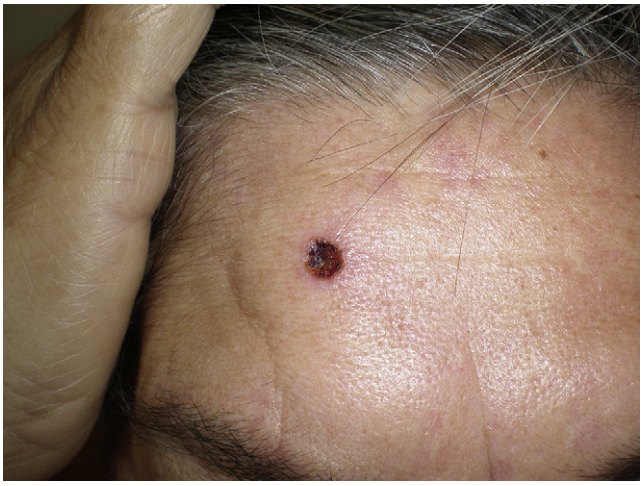

Figure 1 Skin lesion (diameter 0.5 cm) occurring after one week of tDCS treatment at 2 mA stimulation intensity.

In conclusion, patients undergoing tDCS treatment under the conditions described need to be informed about this potential side effect. To reduce the risk for occurrence of skin lesions, one could consider a range of measures in addition to disinfecting the sponge electrodes regularly: wetting the electrodes to avoid drying out, creaming the skin after application to prevent a sensitization after a couple of sessions, and using plastic electrodes of the same surface together with electrode cream to reduce iontophoresis and improve contact between the sponge electrodes and the skin. Finally, there is a need for assessing this side effect carefully in future investigations.

Ulrich Palm
Daniel Keeser
Christina Schiller
Zoe Fintescu
Michael Nitsche*
Eva Reisinger
Frank Padberg
Department of Psychiatry and Psychotherapy
Ludwig-Maximilian University
Munich, Germany
[*]Department of Clinical Neurophysiology
Georg-August University
Göttingen, Germany

References

1. Fregni F, Boggio PS, Nitsche MA, et al. Treatment of major depression with transcranial direct current stimulation. Bipolar Disord 2006;8:203-205.
2. Boggio PS, Rigonatti SP, Ribeiro RB, et al. A randomized, double-blind clinical trail on the efficacy of cortical direct current stimulation for the treatment of major depression. Int J Neuropsychopharmacol 2008;11: 249-254.
3. Rigonatti SP, Boggio PS, Myczkowski ML, et al. Transcranial direct stimulation and fluoxetine for the treatment of depression. Eur Psychiatry 2008;23:74-76.
4. Nitsche MA, Liebetanz D, Lang N, et al. Safety criteria for transcranial direct current stimulation (tDCS) in humans. Clin Neurophysiol 2003; 114:2220-2222.
5. Iyer MB, Mattu U, Grafman J, et al. Safety and cognitive effect of frontal DC brain polarization in healthy individuals. Neurol 2005;64:872-875.
6. Dundas JE, Thickbroom GW, Mastaglia FL. Perception of comfort during transcranial DC stimulation: effect of NaCl solution concentration applied to sponge electrodes. Clin Neurophysiol 2007;118:1166-1170.