

Letters

Long-Term Analgesic Effects of Transcranial Direct Current Stimulation of the Motor Cortex on Phantom Limb and Stump Pain: A Case Report

To the Editor:

Phantom limb pain (PLP) is a neuropathic pain syndrome characterized by pain in the amputated limb that follows partial or complete deafferentation;¹ it must be differentiated from nonpainful phantom limb phenomena and stump pain occurring in the still-present body part adjacent to the amputated or deafferented nerve.¹ PLP is considered a challenging clinical condition as it is often refractory to classic pharmacological and surgical treatments.¹ The mechanisms responsible for PLP are not fully understood, but the reorganization of the sensorimotor cortex, including changes in motor cortex excitability, seems to play a major role in the development of PLP.^{2,3}

Increasing the excitability of the motor cortex by means of anodal transcranial direct current stimulation (tDCS), a noninvasive technique of electrical brain stimulation that can modulate neuroplasticity,⁴ has been shown to be effective in the management of neuropathic pain.⁵ However, the efficacy of this approach for the treatment of postamputation pain still needs to be determined.

Recently, we showed that 15 minutes of anodal tDCS of the motor cortex can induce a selective short-lasting relief from PLP, without affecting stump pain or other nonpainful phantom limb phenomena.³ Herein, we describe the case of a lower limb amputee in whom repeated applications of anodal tDCS to the motor cortex induced long-lasting analgesic effects on both PLP and stump pain.

Case

The patient was a 60-year-old male, retired taxi driver, who underwent a below-the-knee amputation, after peripheral vasculopathy and an unsuccessful bypass intervention. The phantom leg emerged immediately after amputation, which occurred about nine months before the experiment. The phantom leg was described as identical to the lost leg; the patient said that he was able to voluntarily move only the toes of the phantom foot, but not the remaining part of the phantom leg. He also experienced uncomfortable tingling/itching, continuous and severe PLP, and pain at the extremity of the stump. The PLP and stump pain worsened when the patient wore his aesthetic prosthesis. At the time of the study, the patient was taking anticonvulsant, analgesic, and proton pump inhibitor drugs.

The patient underwent two weeks of tDCS treatment, each comprising five daily, consecutive sessions of tDCS. During the first week, sham tDCS was used, followed by a second week of treatment with active tDCS. The outcome of the treatment for the patient was compared with that of a control group, comprising six patients with unilateral lower limb amputations from a previous study,³ who underwent two single tDCS sessions only, one with active and one with sham tDCS. The two sessions were separated by at least three hours and given in random order.³ The study was approved by the local ethics committee; none of the participants had neurological or psychiatric diseases or any contraindication to tDCS.⁴

Active tDCS (2 mA for 15 minutes) was delivered by a battery-driven (neuroConn GmbH, Ilmenau, Germany) constant current stimulator using a pair of surface saline-soaked sponge electrodes (5 × 7 cm). The anodal electrode was placed over the motor cortex

(C3–C4 in the electroencephalography 10/20 system) and the cathode electrode over the contralateral supraorbital area; the hemisphere of stimulation was contralateral to the amputation.³ For sham tDCS, the current was ramped up over 30 seconds and then switched off.³

Four visual analogue scales (VASs; 10 cm in length, graduated from zero to 10) were used to measure the tDCS effects on PLP, stump pain, nonpainful phantom sensation, and telescoping (see Bolognini et al.³ for details). For each VAS, we computed the mean percentage of improvement induced by tDCS, normalized against the score at baseline as $([\text{post-tDCS} - \text{pre-tDCS}] / \text{pre-tDCS} \times 100\%)$.⁶ The patient's improvement was compared with that of the control group, following the procedure for single-case analysis developed by Crawford and Garthwaite.⁷ At baseline, with daily

medications, the patient scored seven of 10 on the VAS for PLP, and six of 10 on the VAS for stump pain.

After the five-day treatment with active tDCS of the motor cortex, the patient showed a reduction in PLP similar to that of the amputees receiving a one-day session of tDCS (-86% vs. -66% , $t = -0.01$, $P = 0.4$). He also showed a significant reduction in the stump pain (-100% , $t = 8.33$, $P < 0.0001$) compared with the controls (-10%). Neither in the patient nor in the controls did motor tDCS affect non-painful phantom sensation (0% vs. 25% , $t = -1.36$, $P = 0.2$) and telescoping (0% vs. 21% , $t = -1.22$, $P = 0.3$; Fig. 1a). Importantly, at subsequent follow-ups, the overall levels of PLP and stump pain remained stable (Fig. 1b), whereas no effect was found in controls after 90 minutes.³ No effect was found for the sham stimulation.

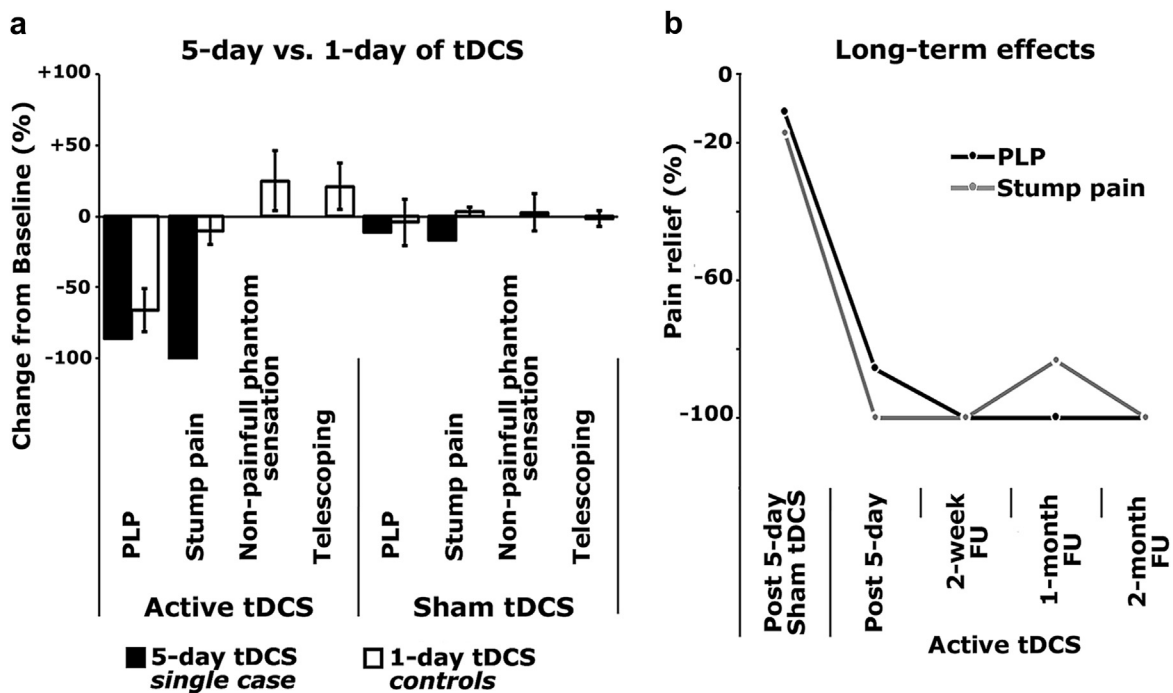


Fig. 1. a) Effects of a five-day treatment with sham and active anodal tDCS of the motor cortex in a lower limb amputee with chronic pain, as assessed by Visual Analogue Scale (VAS) for PLP, stump pain, nonpainful phantom sensation, and telescoping. The VAS scores were normalized against the baseline score and displayed as percentage of change; a zero value indicates absence of change, a -100% value indicates complete pain relief. The patient's score (black bars) at each VAS was compared with that of six lower limb amputees with chronic pain (controls, white bars), tested in a previous study,³ who received only one application of active and sham motor tDCS. b) Long-term relief from PLP (black line) and stump pain (gray line) reported by the patient after the five-day treatment with active anodal tDCS of the motor cortex. tDCS = transcranial direct current stimulation; PLP = phantom limb pain; FU = follow-up.

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