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Effect of transcranial direct current stimulation on pain anxiety during burn wound care

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ABSTRACT

Background: Changes in neuronal activity by cathodal transcranial direct current stimulation (tDCS) of the sensory cortex can relieve acute pain. Studies have demonstrated high correlation between burn pain and anxiety in burn patients. The aim of this study was to assess the effect of tDCS on pain anxiety in patients with severe burn.

Methods: In a controlled randomized clinical trial, 60 subjects who were hospitalized during the year 2014 in the Department of Burn and Reconstructive Surgery of Imam Reza Hospital of Mashhad were selected as the sample for this study. The patients were randomly assigned to one of the two groups. A cathodal stimulation group that received real 1.0 mA tDCS over sensory cortex lasted 20 min and the control group received sham tDCS. Pain anxiety was obtained by self-report pain anxiety questionnaire before and after stimulation. It was also completed immediately after burn dressing. The data were analyzed by performing the Chi-square, Fisher's exact, independent samples *t*, paired samples *t*, Mann-Whitney and Wilcoxon tests using SPSS 11.5 software.

Results: Pain anxiety score reduced significantly in the real tDCS compared with sham group (23.4 ± 3.8 versus 29.3 ± 2.0, $p \leq 0.001$). After stimulation there was a decrease in pain anxiety score in real tDCS group ($p = 0.010$).

Conclusion: According to our study, cathodal cortical stimulation with tDCS is associated with significant reduction in pain anxiety in burn patients.

1. Introduction

Severe burn injury can be extremely devastating and distressing for the survivors [1]. Wound care and therapies is commonly associated with severe anxiety that manifests as scared feeling and prediction of wound dressing pain [2]. Studies demonstrated a bidirectional relationship between wound dressing pain and anxiety [3]. It is also found that anxiety can worsen burn pain [3]. Anxiety arises from poorly managed pain especially when pain relief medication is not initiated before wound care or procedures [4]. Patients who

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have higher level of anxiety tend to have less pain tolerance [4]. Moreover, pain anxiety can result in non-compliance (non-adherence) with hospital cares, sleep disturbance and decreased appetite [5,6]. Therefore it is of paramount importance to reduce pain anxiety in effective patients care of burn patients. Many medication and non-medication methods were found to control pain anxiety. Medications comprise anesthetic drugs and opiate that have side effects like undertreated pain, respiratory depression, nausea and vomiting and hyper sedation [7]. Non opiate drugs such as ketamine and propofol can greatly relieve wound dressing pain but the use of them is limited due to required vital care [8–10]. Non medication methods such as behavioral therapy, education and giving primary information to patients, hypnotherapy and complementary medicine techniques like relaxation and relaxing breathing ameliorate burn pain but cannot completely control pain anxiety unless accompanied by additional opiates drugs [11–13]. Noninvasive methods can also effectively control the pain anxiety. There are some evidences showing any change in neuronal activity and excitability of sensory cortex by cathodal transcranial direct current stimulation (tDCS) could ameliorate acute pains [14,15]. This method also causes change in concentration of Gama aminobutiric acid and glutamate in stimulated area of the cortex [16]. It is also an established method in relieving acute pain following Tm: YAG laser, knee arthroplasty and ERCP [14,17,18]. Since there is a bidirectional association between pain and pain anxiety [3], tDCS can probably reduce the pain anxiety. To the best of our knowledge, this is the first study that investigates the effect of tDCS on pain anxiety in burn patients. Regarding to importance of preventing and relieving the pain in burn patients, we designed this study to assess the efficacy of transcranial direct current stimulation of sensory cortex in decreasing pain anxiety in burn patients.

2. Methods

This randomized controlled clinical trial was conducted in the Department of Burns and Reconstructive Surgery at Imam Reza hospital of Mashhad, Iran, in 2014. The study was approved by the Ethics Committee of the Mashhad University of Medical Sciences. Study population consists of patients who were hospitalized in the burn department. The inclusion criteria were as follows: (1) burns of 20–50 percent TBSA (total body surface area); (2) second or third degree burns; (3) the ability to read and write; (4) the ability to speak and communicate; (5) being in the acute phase of burn injury; (6) being right hand; (7) lack of any burn, lesion, tumor and implants in scalp; (8) lack of metal implants like pacemakers over waist; (9) lack of history of severe and repetitive headache, head injury, psychiatric disease, epilepsy, diabetes and malignancies. In urgency situation like respiratory distress and electrolyte disorders, the patients were excluded.

To estimate sample size the independent sample t-test at the level of 5 percent and a power of at least 80 percent based on the results of a pilot study with two groups of 5 participants each (21.20 ± 4.3 and 24.55 ± 4.7 for study and control groups, respectively) is used and the sample size for each groups was at least 30.

Sixty subjects were enrolled in the study by convenient sampling methods and then were randomly assigned to one of the two groups (30 patients in real tDCS group and 30 patients in sham tDCS group) by stratified sampling method based on variables such as factors, degree, percentage and location of burn, age and sex. A written informed consent was obtained from all participants. Patient medication checklists (type and dosage of analgesic and sedation drugs) were completed by investigator. Dressing was performed by five skillful nurses in wound dressing. The patients underwent transcranial direct current stimulation immediately before wound dressing, so those participants in real tDCS group received stimulation with the current intensity of 1 mA for 20 min but the control group received sham tDCS. However, in the sham group, the same treatment protocol was initiated and after 30 s of stimulation, the tDCS device was turned off. In patients whose more affected area of the body were left side, the sensory cathodal electrode was positioned over the right sensory cortex above the right posterior central sulcus and anodal electrode positioned over the left prefrontal cortex representational the area above the left eyebrow. In patients whose more burned area of their bodies were right side, the cathodal electrode was positioned over left posterior central sulcus and the other electrodes were positioned above the right eyebrow. We used electroencephalogram international system 10–20 to identify the location of the electrodes [14]. We used a self-report questionnaire to evaluate the level of the pain anxiety score. The questionnaire included nine questions and the responses were stratified according to severity of anxiety into four categories of no (1 point), mild (2 points), moderate (3 points) and severe (4 points). The score 9 represented no anxiety and score 36 represented the highest level of anxiety in each measurement. The questionnaire was completed before the intervention (for evaluation of background pain anxiety), after intervention to the beginning of painful stimulation and immediately after wound dressing (after painful stimulation) [18]. The construct and content validity of the self-report pain anxiety questionnaire were previously confirmed by experts [19]. Manzari et al. used sixty experts' views to determine the content validity of the questionnaire after translation to Farsi [20]. In addition, content validity of the questionnaire was confirmed in one cross-sectional study performed by Ghazalche et al. [21]. The questionnaire's reliability was 69% using the Cronbach's Alpha method [21]. Normal distribution of quantitative data was assessed by the Lilliefors test by using SPSS software version 11.5. We used the chi-square, Fisher's exact tests, independent sample t-tests and the Mann-Whitney test to assess homogeneity of the variables. Paired-samples (or Wilcoxon test) and independent-samples t-test (or Mann-Whitney test) were used for baseline comparisons between the two groups.

3. Results

In the present study, 23 (76.7%) out of 30 subjects in the real tDCS group were men and 7 (23.3%) were women. In sham tDCS group, 16 (53.3%) out of 30 patients were men and 14 (46.7%) were women. The mean age in real tDCS group was