The Effects of Transcranial Direct Current Stimulation on Obsession-compulsion, Anxiety, and Depression of a Patient Suffering from Obsessive-compulsive Disorder

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**Objective:** Obsessive-Compulsive disorder (OCD) is one of the greatest and debilitating disorders, which many of its patients do not respond to psychotherapy and pharmaco-therapy. In this regard, paying attention to new treatments such as transcranial direct current stimulation (tDCS) is important. The purpose of the present research was to examine the effects of tDCS on the obsession-compulsion (OC), anxiety, and depression of a patient suffering from OCD.

**Methods:** The present study conducted on a 23-year-old female patient with OCD. tDCS sessions were lasted 10 days, one session per day and each session of about 20 minutes with 2.0 mA intensity. The results of Beck depression inventory, Hamilton anxiety rating scale, and Yale Brown obsessive-compulsive scale showed decrease in OC, depression, and anxiety symptoms after 10 sessions of tDCS.

**Results:** The results of the present research using cathodal tDCS on orbitofrontal cortex in 10 sessions showed that this montage is a powerful and successful treatment for patients with OCD and alleviate their OC, depression, and anxiety symptoms.

**Conclusion:** The data were analyzed by diagram analysis and improvement percentage. This study showed that anodal tDCS on O2 and cathodal tDCS on orbitofrontal cortex improved OC, anxiety and depression symptoms. However, our findings give introductory confirmation that our patient with OCD has a positive response to cathode tDCS of the OFC.

1. Introduction

Obsessive-compulsive disorder (OCD) is a debilitating psychiatric disorder with 2% lifetime prevalence (Ruscio, Sten, Idvin, Chiu, & Kessler, 2010). It is one of the most prevalent psychological disorders. OCD leads to terrible impairments in relationship with other people and occupational responsibility (Fontenelle, Fontenelle, & Borges, 2010). It is supposed that OCD will become the sixth most debilitating psychi-
Its demolishing effects on patients’ life, it seems necessary to consider new technologies to treat OCD patients. In many research studies, OCD is comorbid with depression and anxiety (Ivarsson, Melin, & Wallin, 2008; Peris et al., 2010). Depression leads to drawbacks of treatment outcomes for individuals with OCD (Storch et al., 2008). Anxiety also is more prevalent than depression in OCD (Ivarsson, Melin, & Wallin, 2008; Langley, Lewin, Bergman, Lee, & Piacentini, 2010). The severity of anxiety will be great if the symptoms of OCD increase (Langley et al., 2010). Regarding the high prevalence of OCD and its demolishing effects on patients’ life, it seems necessary to consider new technologies to treat OCD patients.

According to conducted research studies over past 20 years, there is an increased activity in the orbitofrontal cortex (OFC) in patients with OCD (Del Casale et al., 2011; Milad & Rauch, 2012), including the dorsolateral prefrontal cortex (DLPFC), orbitofrontal cortex (OFC), medial prefrontal cortex, anterior cingulated gyrus, supplementary motor area (SMA), and basal ganglia (Shah, Pesiridou, & Baltuch, 2008). The connections of the ventral striatum with prefrontal cortices are considered to be increased in these patients (Del Casale et al., 2011; Shah, Pesiridou, & Baltuch, 2008). OFC plays a major role in the pathophysiology of OCD because obsessions and compulsions are mediated by hyperactivity of the orbito-frontal cortex either bilaterally (Alptekin et al., 2001) or unilaterally (left side) (Baxter, Schwartz, & Mazziotta, 1998; Swedo et al., 1992).

Further pathophysiological insight came from the application of the noninvasive brain stimulation techniques, i.e. transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS). Noninvasive brain stimulation techniques such as tDCS is a vigorous and convenient technique to moderate brain activity. Anodal tDCS increases excitability of cortex in the special area of the brain, while cathodal tDCS decreases excitability of cortex in the specified area of the brain (Nitsche & Paulus, 2000) by producing low-intensity electric field (<1 V/m) (Datta et al., 2009).

In other words, cathodal and anodal stimulations hyperpolarize and depolarize neurons respectively (Priori, Hallet, & Rothwell, 2009; Nitsche et al., 2003). This technique has shown optimistic results in many neuropsychiatric illnesses (Kuo, Paulus, & Nitsche, 2014) and also has some advantages such as low cost, ease of use, portability, and safety (Volpato et al., 2013; Brunoni et al., 2011) over other techniques such as repetitive transcranial magnetic stimulation.

Previous studies have reported that noninvasive techniques such as tDCS alleviate the symptoms of treatment-resistant OCD (Jaafari et al., 2012). Volpato et al. (2013) found out that cerebellar-tDCS on DLPFC decreased anxiety and depressive symptoms but not OC symptoms in patients with treatment-resistant OCD. OC symptoms decreased when stimulation was delivered over the SMA or the OFC (Berlin, Neufeld, & Van den Eynde, 2013). In a study by Mondino, Haesebaert, Poulet, Saoud and Brunelin (2015) which used cathodal tDCS on the left OFC (above FP1) and anodal tDCS on the contralateral orbitofrontal region (above O2), they observed considerable decrease (26%) in symptoms of patients with treatment-resistant OCD.

According to the mentioned studies, cathodal tDCS over the pre-SMA, (rather than anodal tDCS) significantly alleviates OCD symptoms (Senco et al., 2015), but it has not yet been identified whether tDCS can reduce simultaneously depression, anxiety, OC symptoms or not. In the present study, we used tDCS because it has an impact on corticostriatal and corticothalamic loops involved in the pathology of OCD (Polania, Paulus, & Nitsche, 2012). Besides, we used Beck depression inventory (BDI) and Hamilton anxiety rating scale (HARS) tests to evaluate the impact of tDCS on depression, anxiety, and OC symptoms.

Considering that a few studies have directly dealt with this issue (no research in Iran and a few in abroad), as well as the novelty of tDCS, the present study is the first to investigate the effect of tDCS efficacy on the treatment for OCD, and especially to evaluate the effect of tDCS on depression, anxiety, and OC symptoms.

2. Methods

In this study, single-subject experimental trial was used in which, firstly, in stage A, primary condition of a patient was assessed by Yale Brown obsessive compulsive scale (Y-BOCS), Beck depression inventory (BDI), and Hamilton anxiety rating scale (HARS). Then, in stage B, experimental trial was done and the subject’s condition in these scales was again assessed in follow up stage. Our participant was a 23-year-old female student, diagnosed with obsessive-compulsive disorder (based on DSM-V criteria) which was referred by a psychiatrist to receive noninvasive brain stimulation treatment because of the failure in response to other treatments. She had a one year history of this disease characterized by obsessions (religious type) without compulsion. Previous treatment with sertraline (for 3 months) did not improve her symptoms. Obsession symptoms of patients began one year ago when university exams started. Obsession symptoms were not found in her family in Mini-mental state examination. She had normal communication...
with her family and friends and did not report any problem in these areas. Patient was informed about the purpose of the study, and gave her written informed consent.

The cathode electrode was placed on the left orbito frontal cortex (OFC) and anode electrode on the contra lateral region (O2). We used a direct current of 2.0 mA for 20 minutes per day for 10 sessions. The 25-cm² rubber electrodes with cotton material, which was moistened with saline to reduce impedance were used. For assessment of obsession/compulsion, anxiety, and depression symptoms, we used the Y-BOCS, HARS, and BDI at the first, fifth, and last session of the treatment and 2 weeks later as follow up. It is important to note that tDCS was started after providing consent form and this research took place at a clinical psychology clinic (a noninvasive center). Obsession, depression, and anxiety symptoms improved during the 10 session’s of treatment.

The inclusion criteria included 1) Diagnosis of OCD by psychiatrist according to the DSM-V and psychological interview, 2) Y-BOCS scores of 17 points or higher by psychiatrist according to the DSM-V and psychological interview, 3) Under no other therapy such as clomipramine, bupropion, or cognitive side effects. Improvement percentage for treatment (Figure 1). Also, there were no significant clinical or cognitive side effects. Improvement percentage for tDCS was 0.73 (Dobson & Mohammad Khani, 2007).

Table 1. Descriptive statistics of the Y-BOCS, BDI, and HARS scores.

<table>
<thead>
<tr>
<th>Y-BOCS score</th>
<th>BDI score</th>
<th>HARS score</th>
</tr>
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<tbody>
<tr>
<td>Baseline</td>
<td>After 5 days</td>
<td>After 10 days</td>
</tr>
<tr>
<td>28</td>
<td>13</td>
<td>10</td>
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These percentages indicated that tDCS has significant therapeutic effects on OC, depression, and anxiety.

4. Discussion

Noninvasive brain stimulation techniques have found progressive applications in the OCD field, providing an important contribution to our understanding of OCD pathophysiology, and offering new opportunities for treatment. The present study aimed to assess the decrease in obsession, depression, and anxiety symptoms via tDCS in a patient with OCD. Evidently, hyperactivation of prefrontal-thalamic circuits and the lack of inhibition of the cortico-striato-thalamo-cortical pathways are implicated in OCD pathophysiology (Alexander, Crutcher, & DeLong, 1989).

According to this theory, DLPFC, OFC, ACC and striatum (specifically the caudate) will be the most important structures (Aronson, Katnani, & Eskandar, 2014) involving in depression, anxiety, and obsession-compulsion. In line with previous studies, we found that cortical cathodal stimulation on OFC will decrease obsession (Jaffari et al., 2012; Berlim, Neufeld, & Van den Eynde, 2013; Mondino et al., 2015) depression, and anxiety (Volpato et al., 2013). The present research is inconsistent with Volpato et al. (2013) which stated that tDCS only decrease anxiety and depressive symptoms but not OC symptoms. Our results showed that tDCS can have significant equal impact on depression, anxiety, and OC symptoms.

It is important to note that Mondino et al. (2015) in their research found after 10 sessions of tDCS, the symptoms of OC did not subside immediately after 10 sessions of tDCS but our patient showed considerable decrease in depression, anxiety, and OC symptoms after 10 sessions of tDCS. In fact, the symptoms of OC reduced 64.28%, symptoms of anxiety 87.5%, and depression 87.5% after 10 sessions. In order to confirm our results, the patient was asked to complete Y-BOCS, HARS, and BDI after 2 weeks, and the results showed decrease in these symptoms after this interval.

Our other results showed that tDCS decreases anxiety symptoms in OCD patient. This finding is consistent with some other studies (Del Casale et al., 2011; Polonia, Paulus, & Nitsche, 2012; Sakai et al., 2011). Dysfunction in caudate nucleus leads to hyperactivity in orbitofrontal and anterior cingulate cortices which are responsible areas of obsessive thought and anxiety. According to Del Casale et al., (2011) and Sakai et al. (2011), the contact of the ventral striatum with prefrontal cortices are considered to increased in these patients.

Plonia et al. (2012) showed that tDCS has an impact on functional cortico subcortical networks, including corticostriatal, and cortico-thalamic loops, which are involved in these disorders. The other results of our research showed that tDCS has incredible effect on depression. This finding is consistent with the findings of other studies (Fregni et al., 2006; Boggio et al., 2008; Loo et al., 2012; Bennabi et al., 2015). According to Berlim, Neufeld and Van den Eynde (2013), the rationale for considering tDCS as an effective
treatment in depression is inducing functional changes in resting membrane potential and cerebral blood flow.

Like other studies, our research has some limitations too. First of all, it is a case study; therefore our results may not be generalized to other patients with OCD. To resolve this limitation, further controlled studies in large patient groups are needed. However, these results suggest that tDCS inhibit the orbitofrontal cortex while activate the occipital area above O2 has an interesting therapeutic potential in obsession-compulsion disorder. Therefore, in a practical way, this montage can be used by therapists to simultaneously treat obsession, anxiety, and depression symptoms.

In conclusion, the results of the present research showed that tDCS by using anode electrode on O2 and cathode electrode on OFC would safely, conveniently, and inexpensively decrease OC, anxiety, and depression symptoms in patients with OCD. Also as few studies has been done to investigate the impact of brain stimulation on these patients, this study might be the practical one and guide behavior therapists to combine their therapies with noninvasive brain stimulation in order to increase beneficial effects of tDCS.

References


Loo, C. K., Alonzo, A., Martin, D., Mitchell, P. B., Galvez, V., & Sachdev, P. (2012). Transcranial direct current stimulation for depres-


