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Title: Transcranial Direct Current Stimulation (tDCS) Consequences on Dorsolateral Prefrontal Cortex in Reducing the Symptoms of the Obsessive-Compulsive Disorder

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Abstract

Obsessive-Compulsive Disorder (OCD) is one of the most common debilitating mental disorders that has a general rate of 2 to 3 percent prevalence. Previous studies indicated that there are abnormalities in the dorsolateral prefrontal cortex (DLPFC) of OCD patients, so we decided to use transcranial direct current stimulation (tDCS) to decline the symptoms of these patients.

A total number of 24 OCD patients participated in this study with the hope of improvement after the application of tDCS. The subjects were randomly assigned into three groups as Sham, Right DLPFC and Left DLPFC tDCS were applied for 5 consecutive days as in each session patients are subjected to 2 mA current flow for two 15 minutes lasting period following by a 10 minutes rest in between (every session lasts for 40 minutes).

Subsequently, the changes in obsessive-compulsive level and cognitive functions were evaluated via Yale-Brown and Depression Anxiety Stress Scale 21 (DASS-21) test by comparing the results before (pre-test) and after (post-test) tDCS treatment.

Ultimately, the results of the Yale-Brown test in Left DLPFC shows significant changes have occurred after treatment with tDCS (average difference with sham group -6.18 and P value ≤ 0.05). Hereupon, this study demonstrates that transcranial direct current stimulation may cause improvements in symptoms.

Keywords: Obsessive-Compulsive Disorder; dorsolateral prefrontal cortex, transcranial direct current stimulation; Yale-Brown test
Introduction:

Obsessive-compulsive disorder (OCD) is a rather common psychiatric disorder, characterized by the presence of obsessions and/or compulsions. OCD is defined as unwanted intrusive and recurrent thoughts, urges or images (obsessions) and repetitive behaviors or mental acts that the individual feels driven to perform in response to an obsession or according to rules that patients believe must be applied rigidly (compulsions) (D’Urso et al., 2016).

Studies showed that OCD may be associated with both genetic and adventitious factors whereas, it has about 2-3% lifetime prevalence (Brunelin et al., 2018; Meyer, 2013). This disorder also has 1-3% prevalence in children and teenagers wherein 75% of them suffer from other anxiety disorders such as anxiety disorders, oppositional defiant disorder, attention-deficit/hyperactivity disorder and Tourette’s disorder (Ost et al., 2016).

Symptoms are included intrusive and recurrent thoughts and urge leading to compulsive and repetitive behaviors or mental acts (Brunelin et al., 2018; D’Ursoa et al., 2015; K, K, J, MJ, & E, 2005). Meyer believed that the emergence of these thoughts depends on religiosity, self-esteem, and personality characteristics (Meyer, 2013). In 30-50% of adults with OCD, the early symptoms would commence in childhood or early adulthood and in the absence of treatment it may lead to subjective distress as well as a social disability (D’Ursoa et al., 2015; Ost et al., 2016). By the devaluation of the life quality, OCD has been ranked as one of 10 most handicapping conditions by the World Health Organization. Studied revealed the frustration caused by this disorder leads to high levels of subjective distress and social disability and suicidal thoughts (Angelakis, Gooding, Tarrier, & Panagioti, 2015; D’Urso et al., 2016).

Psychopharmacologic and psychotherapeutic interventions or combination of them are common treatments for OCD, however, they fail to function properly in almost 40% of patients (Brunelin et al., 2018). For that reason, non-pharmacological approaches, such as noninvasive brain stimulation therapies, comprising repetitive transcranial magnetic stimulation (rTMS) and transcranial direct current stimulation (tDCS) are mostly
suggested (D’Ursoa et al., 2015; Mondino, Haesebaert, Poulet, Saoud, & Jérôme Brunelin, 2015). tDCS is an available method enhancing cortical excitability and spontaneous neuronal activity under an anode by generating a weak current between anode and cathode. It is suggested that this method enhances cortical excitability and activity by the generation of action potentials so it could be effective in improving the symptoms of psychiatric disorders (Lefaucheur et al., 2017; Stagg, Antal, & Nitsche, 2018) Accordingly, this method has been suggested to decrease symptoms of OCD (Remy Bation, Poulet, Haesebaert, Saoud, & Brunelin, 2015; Senço et al., 2015). Imaging studies manifested abnormalities in the cortico-striato-thalamo-cortical pathways, especially, the dorsolateral prefrontal cortex (DLPFC)-caudate nucleus-thalamus loop in patients with OCD. At the same time, several pieces of research brought out the benefits of the clinical effects of stimulating DLPFC in other psychiatric conditions (Brunelin et al., 2018). Due to the mentioned above, DLPFC is a promising approach for OCD treatment and we aim to utilize that here in this study.

**Methods:**

24 patients participated in this study including 7 women and 17 men as there were 17 married and 7 single individuals among them. There are three groups in this study containing Sham, Right DLPFC (anode in F4 and cathode in FP1 area), Left DLPFC (anode in F3 and cathode in FP2 area). Subjects were randomly distributed in groups: One woman and five men in Sham group, three women and seven men in Right DLPFC group, and three women and five men in Left DLPFC (Table 1).

All patients were subjected to 2 mA current flow for 30 minutes with a 10-minute rest in between (total session period was 40 minutes). This protocol was performed daily for five days. In order to find a suitable location, international 10–20 electrode placement system and 5*7 cm² electrodes pads were used.

For evaluation of changes in obsessive-compulsive level and cognitive functions, Yale-Brown, and Depression Anxiety Stress Scale 21 (DASS-21) test were used before and after therapy.
All the data were analyzed via SPSS 16. In order to compare the results in Yale-Brown and DASS-21 tests results, the averages and standard deviation of pre-tests and post-tests in all groups are examined. Then the analysis Covariance (ANCOVA) is applied to omit the pretest learning effect. LSD post-test used to demonstrate which between-group differences are significant.

**Results:**

Severity of OCD cases, who were confirmed with clinical diagnosis, are assessed with Yale-Brown test and their scores considered as the pre-test. These scores were between 12 to 30 (with the average of 21 and standard deviation of 4.7) which shows they suffered from mild to severe OCD (Rapp, Bergman, Piacentini, & Mcguire, 2016). Due to examine the aspects of emotional disturbance DASS-21 test was taken too. Table 2 describes the descriptive data of Sham, Left DLPFC, and Right DLPFC groups includes the score averages and standard deviations of both taken tests in each group.

In order to statically controlling the influence of pre-test, covariance analysis is performed (Table 3). The significance in P value of this test shows there is at least one significant difference in between group results. So The LSD post-test has done to show which has that. We are able to observe a significant difference between Left DLPFC and sham groups in Yale-Brown test (Table 4). No significant differences is observed in DASS-21 test.

**Discussion:**

Studies showed stimulating DLPFC has some beneficial effects in psychiatric conditions with an abnormality in this area (Brunelin et al., 2018). We aimed to reduce the clinical symptoms of OCD and attempted to employ a non-invasive method of tDCS in two regions, Left DLPFC and Right DLPFC.

In this study, OCD patients experienced a protocol of tDCS treatment (2 mA current flow for 15 minutes with 10 minutes rest in between, in 5 days), and their Depression, Anxiety, Stress level, and OCD symptoms are assessed with DASS-21 and Yale-Brown tests. Peoples who were in both groups of Left and Right DLPFC had no significant
results in scores of the DASS-21 test. Although our results have not demonstrated any significant difference in Right DLPFC, another study on five patients using a different protocol in 15 days, demonstrated significant improvements (Dinna et al., 2016). One reason for the absence of this significance could because of high variation in score results that increases the standard deviation. This problem may solve by enhancing the number of cases in all groups. More than that, it is possible that a longer period of treatment may show more satisfying results. One promising point which powers these ideas is that there is not also any significant difference in pre-tests and post-tests of Sham group.

We observed a significant improvement in the Yale-Brown test in Left DLPFC. This shows that this protocol has some positive effects on decreasing the difficulties caused by OCD.

There are many other studies employing tDCS to reduce problems caused by OCD with different protocols and areas (Rémy Bation, Mondino, Le Camus, Saoud, & Brunelin, 2019; Remy Bation et al., 2015; Brunelin et al., 2018; D’Ursoa et al., 2015; Goradel, Pouresmali, Mowlaie, & Movahed, 2016; Mayur, 2016; Mondino et al., 2015; Najafi et al., 2017; Palm et al., 2017; RM, AR, EC, & RG, n.d.; Senço et al., 2015).

Improvements in treatment with tDCS in different areas suggest that there is not only one specific area Interfere with OCD affection, but also, it seems that OCD involves more complex and extended neurological pathways.

**Conclusion:**

Applying tDCS as a non-invasive method in Left DLPFC area for decreasing difficulties of OCD is effective.

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References:


<table>
<thead>
<tr>
<th>Test</th>
<th>Average Pre-test</th>
<th>Standard deviation Pre-test</th>
<th>Average Post-test</th>
<th>Standard deviation Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yale-Brown (Sham)</td>
<td>18.88</td>
<td>4.390</td>
<td>17.00</td>
<td>7.783</td>
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<tr>
<td>DASS-21 (Sham)</td>
<td>29.75</td>
<td>10.209</td>
<td>24.62</td>
<td>14.071</td>
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<tr>
<td>Yale-Brown (Left DLPFC)</td>
<td>21.50</td>
<td>4.660</td>
<td>0.38</td>
<td>0.744</td>
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<tr>
<td>DASS-21 (Left DLPFC)</td>
<td>30.50</td>
<td>15.137</td>
<td>25.87</td>
<td>13.206</td>
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<tr>
<td>Yale-Brown (Right DLPFC)</td>
<td>22.62</td>
<td>4.809</td>
<td>15.50</td>
<td>6.761</td>
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<tr>
<td>DASS-21 (Right DLPFC)</td>
<td>20.87</td>
<td>14.980</td>
<td>14.25</td>
<td>13.551</td>
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Table 2. Descriptive data of Yale-Brown and DASS-21 test in all groups.
<table>
<thead>
<tr>
<th>Test</th>
<th>Sum of squares</th>
<th>Average Squares</th>
<th>Degrees of freedom</th>
<th>F</th>
<th>P value</th>
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<tr>
<td>Modified Model</td>
<td>714.41</td>
<td>238.13</td>
<td>3</td>
<td>19.25</td>
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<tr>
<td>Covariate variable</td>
<td>700.07</td>
<td>700.07</td>
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<td>59.59</td>
<td>0.0001</td>
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<tr>
<td>independent variable</td>
<td>68.06</td>
<td>136.13</td>
<td>2</td>
<td>5.50</td>
<td>0.012</td>
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<tr>
<td>Error</td>
<td>12.37</td>
<td>12.37</td>
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Table 3. Covariance test results

<table>
<thead>
<tr>
<th></th>
<th>Average difference</th>
<th>P value</th>
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<tbody>
<tr>
<td>Left DLPFC</td>
<td>-3.155</td>
<td>0.09</td>
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<tr>
<td>Sham</td>
<td>-6.18*</td>
<td>0.003</td>
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<tr>
<td>Right DLPFC</td>
<td>3.155</td>
<td>0.09</td>
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<tr>
<td>Sham</td>
<td>-3.02</td>
<td>0.11</td>
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Table 4. The result of LSD post-Test