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# Neuroplastic Changes and Effect of Anodal Transcranial Direct Current Stimulation in Non-Specific Chronic Low Back Pain

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**Abstract:** ***Neuroplasticity in chronic low back pain occurs as a result of cortical changes due to the chronicity of the condition. Functional imagine studies revealed three basic neuroplastic changes in chronic low back pain which are of clincal important. Transcranial direct current stimulation and Transcranial magnetic stimulation are the two important non invasive method of brain stimulation that are used in chronic pain syndrome, with the former being cheaper, safe and easy to blind. This article will review neuroplastic changes in chronic in chronic low back pain as well as the effectiveness of anodal transcranial direct current stimulation in non-specific chronic low back pain.***

**Keywords:** Chronic Low Back Pain, Anodal Direct Current Stimulation and Neuroplastic Changes

## 1. Introduction

Chronic low back pain (CLBP) is a widespread and costly problem for which few interventions are effective [1] (Neil et al 2013). It is the major cause of medical expenses, absenteeism, and disability in developed nations [2] (Maurits, Malmivaara, Esmail, & Koes, 2000), with average one year prevalence and lifetime prevalence of 33%, 50%, 36% and 62% among African adolescents and adults respectively [3] (Quinette, Linzette & Karen, 2007). Larsson, Bjork, Borsbo and Gerdle (2012) non-specific CLBP is define as a pain with no identifiable injury or disease in the spine [4]. However, clinicians and researchers have looked at the structural and functional abnormalities within the musculo- skeletal system for the treatment of the condition.

Study by Robinson and Akparian, (2009); Grachev, Fredrickson and Apkarian, (2000) brain is seen as an explicit target for CLBP treatment due to neuroplastic changes seen from advance neuroimaging technique such as functional magnetic resonance imaging, voxel-based morphometry, magneto encephalography and electroencephalography [5]- [6]. Therefore this article aim to review some of this changes with there clinical importance as well as the effect of using transcranial electrical stimulation in the management of pain and disabilty in chronic low back pain.

## 2. Neuroplasticity in Chronic Low Back Pain

### Neurochemical Changes

The neurochemical profiles of brain in patients with CLBP have been reported from several studies when compared with healthy control subject [6]. Significant changes in which some markers increase while others decrease in the neurochemical profile of dorsolateral prefrontal cortex (DLPFC), thalamus and orbitofrontal cortex have been observed in people with CLBP [6]- [7]. It was reported from research study that the brain of patients with CLBP has some similar features with that of those with neurodegenerative conditions such as Alzheimers disease and multiple sclerosis [6].

### Structural Changes

Researchers have postulated voxel-based morphometry as a statistical method that compared the volume of gray and white matter in specific brain region [8]. A fairly compelling evidence of reduced gray matter in the DLPFC [8]- [9] , right anterior thalamus [9], brainstem and somatosensory cortex [8] and the posterior parietal cortex [10] were seen in people with CLBP. Gray matter increases with training in an injured brain, which might also occur in the uninjured part of the brain when a particular body part is stimulated [11].

### Functional Changes

The physical body is represented in the human brain by neurons in many areas, which are evoked mostly when stimulated [12]. However, alterations in the cortical representation in CLBP survivors when compared with healthy control group were reported in the present of noxious stimulus at the back [12]. Moreover, activation of a more expansive network of pain-related brain regions with peripheral noxious input [13] - [14] and acute experimental muscle pain [15] were all seen in CLBP survivors. It appears that CLBP survivors have reduced blood flow in an important part of the descending antinociception system compared with healthy control, when exposed to equally painful stimuli [13].

Primary motor cortex is organized according to body movements [16]. However, shift in primary motor cortex were reported in CLBP, with increase motor cortical representation in the contraction of transversus abdominus muscle, arm movement and decrease specific cortical responses in relation to observed delayed onset of deep abdominal muscles [17]- [18]. Increased motor thresholds

have been reported for lumbar back muscles in CLBP survivors [19] leading to a decrease corticospinal drive to these muscles.

## 3. Clinical Implications of Neuroplastic Changes in CLBP

The clinical implications of an altered brain state are far from being understood [20]- [21]. Three important observations that have to be considered by the therapist in the management of CLBP are:

**Altered Body Perception**

Distortions of cortical representation of the body affect the body perception in CLBP [22] -[24]. Its difficult to the patients to identify letter that are traced on their back [22] , posess poor tactile acuity [25], difficult to delineate the outline of their back when asked to complete a drawing of how it feels [25]. Moreover, in some cases patients reported that they no longer considered their back as being part of them and can not be controlled automatically [26].

**Psychological and Cognitive Effects**

Chronic low back patients have impaired task designed to assess emotional decision making with performance negatively related to pain intensity [9]. Significant impairments in memory, language skills, mental flexibility and reduced ability to shift attention away from pictures of physical activities associated with the threat of back injury were seen in CLBP survivors [27]- [28]. Moreover, distraction increases pain tolerance and threshold in healthy controls compared with CLBP patients [29]. Psychological manifestations of CLBP are undoubtedly multifaceted and likely to be influenced by a variety of inputs, brain changes may need to be considered as an additional contributor to psychological dysfunction [29].

**Increased Response to Noxious Stimuli**

Chronic low back survivors exhibit sensitivity changes away from the back which implicate cortical rather than peripheral or spinal mechanisms [30]. The patients had lower mechanical pain thresholds over the lumbar spine, thumb nail and a combination of sites remote to the lumbar spine compared to healthy controls [13], [14], [30], [31]-[32].

Diffuse tenderness is considered to reflect disturbed nociceptive regulation rather than spinal pathology [32]. It is likely that part of the pain experience by CLBP survivors is mediated by sensitivity changes within the central nervous system due to neuronal plasticity [33]. This is important because a number of manual therapies are thought to mediate their analgesic effects via descending antinociception [33].

**Effect of Transcranial Direct Current Stimulation in CLBP**

Table 2.8 and 2.9 summarized the reviews of combine TDCS/TENS and TDCS in chronic pain. Significant improvement of pain when combine with cognitive behavioral therapy was seen in a study on the effect of anodal transcranial direct current stimulation of primary motor cortex in CLBP [34]. A similar finding was reported in patients with other chronic pain syndrome such as trigeminal neuralgia and poststroke pain [35]. Likewise, a similar findings was reported from an exploratory study [21] with limited sample size, which prevents the generalization of their result.

Comparative study of combine TDCS/TENS and TDCS revealed a significant reduction of pain among the subjects in the group that received combine TDCS/TENS stimulation compare to those in the TDCS group [36]. Negative finding was revealed in a study in which the patients received a single session of TDCS [37]. Base on the literature search for the present study there is paucity of a study that correlate the effect of combine TDCS/TENS and conventional therapy. Moreover, in most of the studies search, primary motor cortex is used as the primary site of electrode placement.

**Table 1:** Positive Findings Using Transcranial Direct Current Stimulations

| Author's Name | Title of study | Technique | Year | Site of stimulation | Parameters of stimulation | N | cause of pain | Results | Type of study |
|---|---|---|---|---|---|---|---|---|---|
| Kerstin Luedtke, Alison Rushton Christine Wright, Tim P Juergens, Gerd Mueller and Arne May | *Effectiveness of anodal transcranial direct current stimulation in patients with chronic low back pain: Design, method and protocol for a randomised controlled trial* | TDCS and Congnitive behavioral therapy (CBT) | 2011 | PMC | 20min, 2mA, 5days stimulation and 4, 12 and 24 week follow up for CBT | 135 | CLBP | Significant combine with CBT | double blind sham control trial |
| Antal A, Terney D, Kühnl S and Paulus W. | *Anodal transcranial direct current stimulation of the motor cortex ameliorates chronic pain and reduces short intracortical inhibition.* | TDCS | 2010 | PMC | 20min, 2mA, 5dapys stimulation | 12 | Trigemnal neuralgia, poststroke pain syndrome, back pain and fibromyalgia | Significant | Exploratory study |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Schabrun SM, Jones E, Elgueta Cancino EL and Hodges PW | *Targeting chronic recurrent low back pain from the top-down and the bottom-up: a combined transcranial direct current stimulation and peripheral electrical stimulation intervention.* | TDCS, TENS | 2014 | PMC | 20min, 2mA, 3days stimulation | 16 | CLBP | Significant | Crossover design |

**Table 2:** Negative Findings Using Transcranial Direct Current Stimulations

| Author's Name | Title of study | echnique | Year | Site of stimulation | Parameters of stimulation | N | ause of pain | Results | Type of study |
|---|---|---|---|---|---|---|---|---|---|
| Kerstin Luedtke, Arne May and Tim P. Jurgens | No Effect of a Single Session of Transcranial Direct Current Stimulation on Experimentally Induced Pain in Patients with hronic Low Back Pain – An Exploratory Study | Single session of TDCS | 2012 | PMC | 15min, 1mA | 15 | CLBP | No significant alteration due to nature of the treatment | Exploratory Study |
| Neil E. O'Connell, John Cossar, Louise Marston, Benedict M. Wand, David Bunce, Lorraine H. De Souza, David W. Maskill, MPhil, Andrew Sharp, and G. Lorimer Moseley | Transcranial Direct Current Stimulation of the Motor Cortex in the Treatment of Chronic Nonspecific Low Back Pain A Randomized, Double-blind Exploratory Study | TDCS | 2013 | PMC | 20min, 2MA for 15days | 8 | CLBP | Significant but cannot be generalize due to small sample size | Exploratory Study |

## 4. Conclusion

There have been evidence suggesting the effectiveness of non invasive brain stimulation in management of chronic pain, while in some cases proves more effective when combine with peripheral stimulation. TDCS is safe, cost effective, easy to blind compare to other non invasive brain stimulation technique. Therapist and researchers need to explored more in this area, looking at the burden and level disability associated with chronic low back pain.

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