

# EXPLORING TRANSCRANIAL DIRECT CURRENT STIMULATION'S POTENTIAL IN NEUROLOGICAL CONDITIONS

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## I. INTRODUCTION

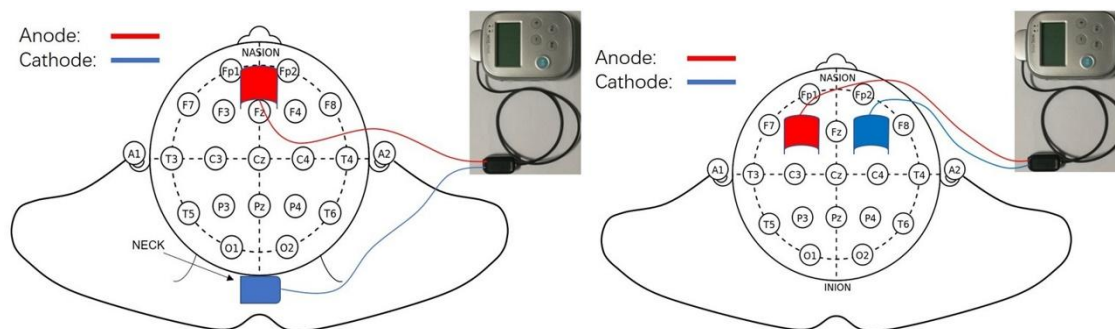
The foundation for the history of neuroscience is comprised of the existing relics of the past, such as artifacts, apparatus, written accounts, data books, photographs, memoirs, and so forth. (12)

TDCS is a technique that uses a continuous direct current (DC) and at least one cephalic electrode to deliver the dose to the head. The procedure of non invasive TDCS is that electronic buffer must be implicated as a separation criteria between electrode and skin (3). To enable research comparability, the TDCS protocol should provide details on the current type and strength, electrode size, and stimulation time. (20)

## II. PHYSIOLOGY OF TDCS

For neuronal resting membrane potential, subthreshold regulation acts as the primary mechanism for the stimulation of direct current (DC) in cerebral cortex. Following conduction of the animal tests, hyperpolarization of neuronal membrane is caused by stimulation of cathode and subthreshold depolarization caused by stimulation of anode. The scenario in individuals is presumably the same because anodal tDCS fully negates any anodal tDCS effect on cortical excitability when administered pharmacologically, but has no effect on cathodal tDCS effects. Direct currents are commonly administered during tDCS using two sponge electrodes made of surface-conductive rubber that are enveloped in saline solution. (1)

- 1. Working:** The enhancement of cortical excitability with low current of 1-2 MA is more with transcranial direct current (TDCS) than anodal direct current stimulation (ATDCS). It works by activating the neurons in particular brain regions, which results in a cortical modification that endures even after the stimulation ceases.



**Figure: TDCS (26)**

2. **Effects:** Abnormal resting-state functional connectivity (rsFC) has been linked to sustained functional impairment in people with neurological disorders. For variable outcomes and to enhance rsFC, TDCS has recently been picked as the prime enhancer (5).
3. **Brain Function:** TDCS helps to establish a non invasive linkage between underlying perception, cognitive motor process and the brain specified regions. During the treatment of primary motor cortex in people, TDCS has been seen to increase stimulation of cathode when done with Motor evoked potential (MEPs) and Transcranial magnetic stimulation (TMs) (9). There have been shown many evidence where cortical activity has been altered by TDCS in many functioning neuroimaging investigation. The primary goal of fMRI is to detect fluctuations in blood flow. The long-term effects of tDCS activation may affect a motor performance, according to fMRI research (15).
4. **Stroke:** A stroke can impact the movement and function of the lower limbs similarly to how it affects the upper limbs, which can lead to gait impairment. Recent advancement in stroke made new relevations of using an innovative non invasive brain stimulation technology called TDCS as a baseline criterion to improve the cognitive function. For chronic stroke patients, Anodal TDCS was applied to the motor cortex of the ipsilesional leg region. This stimulation statistically increased the strength of the knee extensor on the hemiplegic side. Depolarizing or hyperpolarizing brain tissue is the main mechanism of tDCS, which makes it a powerful tool for changing synaptic plasticity in stroke. (22).
5. **Parkinson:** Parkinson disease (PD), a degenerative neurological condition which occurs when there occurs loss or death of dopamine in the substantia nigra which is a region in brainstem. According to studies, tDCS can improve the efficiency of the motor system in both healthy individuals and those in state of malady like Parkinson's disease effecting the central nervous system. Numerous tDCS studies have demonstrated how efficiently it enhances muscle strength and gait speed (29). Clinical experiments have shown that combining tDCS with anodal stimulation of the primary motor cortex (M1) significantly improves motor function in people with Parkinson's disease (PD). The evaluation of the underlying neuronal mechanisms and the tinkering with of variables that significantly influenced the therapeutic advantages of tDCS have, however, received very little study. (18).
6. **Balance:** Multiple functions of the central nervous system (CNS) are involved in postural control. Central pattern generators (CPGs), which are spinal neuronal networks, create the

fundamental posture and movement patterns. A viable component called TDCS has shown to gain its place as a therapeutic strategy, for improving the rehabilitative procedures (6). According to research, Magnetic Resonance Spectroscopy (MRS), it has been observed that the inhibitory neurotransmitter gamma aminobutyric acid (GABA) level is lowered by TDCS of anode and excitatory neurotransmitter glutamate level is lowered by TDCS of cathode. It is envisaged that by utilizing tDCS, an appropriate E/I balance will be restored, enabling sufficient homeostatic plasticity in learning and cognition. If this continues, tDCS can be used to successfully treat a variety of clinical diseases, such as faulty brain development. (16)

7. **GAIT:** Even in the chronic stage of illness, one of the main objectives of neurological rehabilitation is the restoration of gait function. In gait, a crucial role is played by RAGT which makes an individual's walking easier. Preliminary investigations suggest that individually TDCS of anode has no further effects on patients' RAGT. This may be due to the unusual neurological architecture of movement, which combines spinal and brain control. Combining it with tDCS and tsDCS in neurological patients may have a considerable extra effect on RAGT (21). When TDCS of primary cortex combines with treadmill training, the advantages of static balancing and gait effectiveness increases (7).
8. **Cerebral Palsy:** In cerebral palsy, there occurs a variance between the agonist and antagonist movement muscle along with sensory abnormalities and weakness, where there occurs absence of abnormal tone of muscle and selective motor control. By boosting the motor area's cortical excitability during exercise and hence promoting motor learning and neuroplasticity, it is thought that tDCS finds a way to enhance the gain of muscle. (17). In the vast majority of investigations, anodal tDCS was reported to enhance balance, spasticity, cadence, walking patten, speed and body sway. Recent studies confirmed that hand function in school age CP children shown improvement when TDCS of anode was typically administered alone or in combination with some conventional method of therapy unilaterally across the motor cortex (MI) area (14).

### **A Few Cited Examples Of Tdcs Current In Neurological Conditions**

- The current review describes the methods utilized by t-DCS techniques in neurocognitive rehabilitation in terms of its parallels and distinctions. Past researches suggested that a crucial improvement effect has been observed in treatment of cognition in various kinds of neurological disorders such as Parkinson disease (PD), Alzheimer's disease, aphasia. This novel approach to cognitive rehabilitation provides evidence that tDCS can affect cognition. This gives a specific conclusive answer that TDCS can be used as a vital implement for cognitive rehab purpose (4)
- Both cognitive and motor control depend on the cerebellum. A great responsibility is upheld by Transcranial direct current stimulation (ctDCS) for regulating cerebellar excitability. This method has lately become more well-known since it can be used to test how the human cerebellum functions, is simple to administer, is well-tolerated, and hasn't demonstrated any substantial negative effects. Notably, ctDCS is a desirable technology with a possible therapeutic role for neurological patients due to its capacity to alter behavior. The cerebellum's inferior and posterior regions (lobules

VI–VIII) appear to be most responsive to ctDCS modulation. Studies investigating ctDCS as a potential treatment for people with neurological disorders have thus started. (11).

- The emergence of impairment in motor area sets as an onset of Parkinson Disease (PD). With time, it presents as a challenge in therapy due to traceability in regulation of dopamine levels. We examined how the motor and prefrontal cortices responded to 8 sessions of anodal tDCS spread out over 2.5 weeks. The three-month-long exam consisted of timed tests of gait (the primary outcome measure), bradykinesia in the upper limbs, the UPDRS, the Serial Reaction Time Task, the Beck Depression Inventory, the Health Survey, and a self-evaluation of mobility. 12 sham and 13 Tdcs stimulators. For more than three months, TDCS has shown much upgradation in slowness of movement. It also momentarily improved gait in a number of ways. The difference between the tDCS and sham was not seen in terms of the UPDRS changes, response times, physical and mental wellbeing, or self-assessed mobility. For the approach to be therapeutically effective, the stimulation parameters must be improved. The motor and prefrontal cortices in PD may have striking potential in therapy for TDCS. (2)
- Over the course of three sessions, we applied anodal, cathodal, and sham tDCS to the temporoparietal regions of 10 individuals with probable AD. Visual attention and recognition memory tests were conducted before and after each session, respectively, at baseline and 30 minutes later. Observance was done when CtDCS, AtDcs and StDcs were used. When used, the recognised memory task had deflection, as CtDcs had decreased, AtDcs had increased and StDcs remained constant. Conclusion was made that the memory of remembrance categorically altered in patients with Alzheimer's disease (AD) when TDCS was applied over the area of tempo-parietal region (8).

### III. CONCLUSION

An exhaustive collection of sources led to the following conclusion:

1. According to a recent study, tDCS affects more cortical and subcortical systems than only the areas directly underneath the electrodes (24).
2. The rehabilitation of Working Memory (WM) in mental diseases, particularly schizophrenia, may be significantly impacted by anodal tDCS. (19)
3. Language processing and articulation, two additional significant problems that develop after a stroke, can be helped by tDCS. (10)

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