

Assessment of the quality of life following transcranial direct current stimulation in patients with diabetic peripheral neuropathy

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ABSTRACT

Background: Diabetic peripheral neuropathy (DPN) is an impairment of nerve activities in the course of the frame and might disturb autonomic, sensory, and motor functions that affect the patient's well-being. The foremost principle of the study was to examine the influence of transcranial direct current stimulation (tDCS) on the quality of life (QoL) in DPN. **Methods:** Twenty patients of both sexes suffering from DPN participated in the study. The tDCS was used for 20 min, 3 sessions per week for 2 months. Quality of life was assessed using the Neuro-Qol questionnaire before and after the study program. **Results:** There was a significant influence of tDCS on QoL in patients with DPN. **Conclusion:** The study findings suggested that tDCS is effective in improving the overall quality of life in patients with DPN as it has a significant effect in reducing neuropathic pain. Consequently, tDCS reduces anxiety and fatigue and improves upper and lower limb functions with a direct effect on applied cognition, general concern, and depression.

Keywords: transcranial direct current stimulation, diabetic peripheral neuropathy, Neuro-Qol

Introduction

The origin of pain in diabetic peripheral neuropathy (DPN) is not fully understood. Disturbances in the peripheral or central nervous system can be associated with hyperglycemia because this is the main metabolic abnormality of diabetes.^[1]

DPN is an imbalance in the daily activity of the nerves at some areas of the body and may impair the functions of self-movement mobility. The proposed rate of DPN levels is from 16% to an excessive rate such as 66%. In a step with a look at the benefit of fitness and nutrients nationwide Tan et al., studies the cost of treatment of diabetic foot and found early

intervention and conservative treatment will reduce the burden of DF.^[2] Neuropathic ache as "ache springing up as a right away result of lesions or ailment influencing the somatosensory gadget.^[3] Continual neural ache reduces the quality of life, disrupts sleep, and reduces endeavor. Moreover, it extensively affects emotional health and lack of treatment compliance.^[4]

The ache of diabetic neuropathy is troublesome to cause scientific problems. It is frequently related to temper and disturbed sleepiness and patients with diabetic neuropathy look for medicinal treatments more than people with different styles of diabetes.^[5] Patients may also have decreasing of physical activities and movability, increasing of muscle fatigability, and poor consequences in their community life. Providing of substantial pain relief may improve lifestyle practices such as sleeping and liveliness.^[6]

While starting treatment, a real purpose would be to achieve around 50% lowering of pain severity. The secondary purpose is to recover or improve functional parameters, sleep quality, psychological status, and quality of life (QoL). Although it was prospected that pain relief could be achieved by development in capabilities, there is a preferred consent that desirable control

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of blood glucose should be the first step in the management of the DPN.^[7]

In tDCS, a vulnerable non-invasive and painless direct current stimulates the cerebral cortex. It has some advantages that can lead to long-remaining modulation for cortical characteristics, and also it is easy to be administered and performed.^[8]

The tDCS mechanism of action confirmed that it causes polarity-based shifts of the resting membrane potential of neurons beneath the electrodes, thereby converting neural excitation at the site of stimulation and related regions. The anode usually stimulates greater neuronal activities this is why it also includes placed at the target area such as number one motor area (m1), vertex (c3 or c4), or frontal (f 3 or f4) regions.^[9]

Materials and Methods

Subjects

Twenty patients from both sex with diabetic painful neuropathy participated in this study with the age range of 50-60 years old with the mean age of 52.8 ± 1.88 years and BMI range of 34.41-37.22 with mean 36.73 ± 2.49 kg/m². About the sex distribution, there were 12 (60%) females and 8 (40%) males. All patients were provided with a written informed consent before participating in the study.

Inclusion criteria

- Each patient suffers from diabetes since >5 years ago.
- A mild to moderate pain according to visual analogue scale (VAS)
- The patients' age ranged from 50 to 60 years.

Exclusion criteria

- Subjects with an unstable medical or psychiatric disorder.
- Subjects with any device implanted for controlling pain such as deep or vagal brain stimulators.
- Hospitalized subjects.
- Pain not attributed to other causes such as spinal cord injury.

Instrumentations

For assessment of the quality of life, the neuropathic quality of lifestyles (neuro-QoL) was used. Neuro-QoL questionnaire includes short forms that contains group of

items, which have been carefully selected from item banks to facilitate the estimation of each affected person's health.^[10]

To assess pain, the neuropathy pain scale (NPS) was adjusted to assess the quality of pain associated with neuropathy. The NPS consists of 10 items.

Treatment procedures

Transcranial direct current stimulator (tDCS)

Gymna Uniphy device (Phyaction 787) was used in the treatment procedures. It is an advanced electrotherapy device that can produce wide range of electric current from low- to medium-frequency currents passing through one or two output channels, with or without the use of the built-in vacuum unit.

Procedures of application of tDCS:

- The anode electrode has been placed above the primary motor cortex (m1) while cathode has been placed above the supra-orbital area. The DC was commenced with an increase in a ramp-like mode for many seconds up to achieving 1 mA (0.04 mA/cm² current density).
- The session has been stopped if the subject felt headache, severe itching sensation or severe numbness under the electrode areas, dizziness, or experience of vomiting.

Statistical analysis

Data analysis was carried out using SPSS software version 19 (SPSS, Chicago, Illinois, USA). A paired t-test was used to compare between pre- and post-study measures (mean values of neuropathic pain and QoL scores) within each group. The statistical significance was set at $p < 0.05$.

Results

The purpose of the study was to assess the influence of transcranial direct current stimulation (TDCS) on QoL in diabetic peripheral neuropathy. Data obtained from patient groups regarding the neuropathic quality of life (Neuro-QoL) and neuropathy pain scale (NPS) were statistically analyzed and compared before initiation and after completing the treatment program.

Table 1. Comparison between pre and post-treatment mean values of the neuropathy pain scale

	Pre- $(\bar{X} \pm SD)$	Post- $(\bar{X} \pm SD)$	MD	% of change	t- value	p-value	Sig
Sharp	7.6 ± 0.75	3.75 ± 2.24	3.85	50.65	9.34	0.0001	S
Hot	7.9 ± 0.85	3.15 ± 0.93	4.75	60.12	21.97	0.0001	S
Dull	7.85 ± 0.93	3.15 ± 1.34	4.7	59.87	15.22	0.0001	S
Cold	7.9 ± 0.96	3.15 ± 0.74	4.75	60.12	16.43	0.0001	S
Pain	7.75 ± 0.71	3.6 ± 1.46	4.15	53.54	13.02	0.0001	S
Sensitive pain	8.15 ± 0.93	2.05 ± 0.99	6.1	74.84	21.78	0.0001	S
Itchy pain	8 ± 0.97	2.15 ± 1.22	5.85	73.12	16.03	0.0001	S
Unpleasant pain	8.05 ± 0.88	2.4 ± 1.42	5.65	70.18	17.29	0.0001	S
Deep pain	7.95 ± 0.75	2.45 ± 1.31	5.5	69.18	14.72	0.0001	S
Surface pain	8.4 ± 0.82	2.25 ± 1.2	6.15	73.21	17.57	0.0001	S

\bar{X} : Mean; SD: Standard deviation; MD: Mean difference; t-value: Paired t-value; p-value: Probability value; S: Significant

Table 2. Comparison between pre and post treatment mean values of Neuro- QoL questionnaire

	Pre- ($\bar{X} \pm SD$)	Post- ($\bar{X} \pm SD$)	MD	% of change	t- value	p-value	Sig
Sigma	1.7 \pm 0.73	1.35 \pm 0.48	0.35	20.58	3.19	0.005	S
Applied condition	2.05 \pm 0.88	4.5 \pm 0.6	-2.45	119.51	-10.97	0.0001	S
Depression	4.1 \pm 0.64	1.45 \pm 0.82	2.65	64.63	12.69	0.0001	S
General concern	2.3 \pm 0.73	3.95 \pm 0.75	-1.65	71.73	-11	0.0001	S
Anxiety	3.5 \pm 0.6	1.9 \pm 0.64	1.6	45.71	9.49	0.0001	S
Fatigue	3.55 \pm 0.82	1.9 \pm 0.64	1.65	46.47	7.9	0.0001	S
Lower limb function	2 \pm 0.56	3.9 \pm 0.71	-1.9	95	-9.97	0.0001	S
Upper limb function	3.75 \pm 0.78	4.75 \pm 0.44	-1	26.66	-4.87	0.0001	S

\bar{X} : Mean; SD: Standard deviation; MD: Mean difference; t-value: Paired t-value; p-value: Probability value; S: Significant

Discussion

The current study showed a significant decrease in tactile pain score, with a change of 74% compared to pre-treatment and this is in accordance with the study performed by Marlow *et al.*, 2013 who provided that HF rTMS (High frequency repeated transcranial magnetic stimulation), as well as anodal tDCS stimulation of m1 (M1-tDCS) provided parallel ache upgrades compared to the FDA-approved drugs for fibromyalgia.^[11]

For persistent primary pain due to traumatic spinal cord injury, five daily periods of tDCS (motor cortex for 20min) reduced 50% of pain level in 6 of 11 individuals conducting prescribed therapy. Moreover, Zaghi *et al.* advocated a significant increase of 20-30% with 10 times per day among patients with fibromyalgia conducting DLPFC or motor cortex stimulation.^[12]

Although the facts about the using of tDCS for ache relief are limited and great clinical trials are needed to be performed, the results of studies carried out with the aid of previous which displayed that the anodes of tDCS were applied over the motor cortex in patients with continual ache can set off substantial ache comfort, in comparison to the baseline level previous to the tDCS.^[13-15]

The present study found out extensive lower in itchy pain rating put up intervention compared to pre treatment that comes in accordance with randomized clinical trials emphasized that stimulation of the cortex outstandingly decreases ache related to several chronic conditions, which appear in patients with fibromyalgia.^[16-18]

In number of studies, showed the persistence of the effect post stimulation, with trials exhibiting ache enhancements remaining for 4-month after stimulations. Similar protocols executed by Knotkova *et al* yielded sizeable pain relief in sufferers with continual neuropathic pain of numerous etiologies.^[19] The effects of this technique showed a great growth in implemented cognition score put up treatment than before treatment that approved by Kuo and Nitsche who reported useful consequences on the motor and cognitive capabilities.^[20]

Outcomes of our study also go along with prior study which stated that the using of tDCS for one session with 1 mA for seventeen minutes or eighteen sessions with 2 mA for thirty minutes resulted in varied cognition improvement of the participants.^[21] These outcomes pass on with Iuculano and Cohen, Cohen *et al*, and Snowball *et al* that reported cognitive improvements after 6 months of stimulation with tDCS, and may linger beyond then.^[22-24]

Within the contemporary observe the massive improvement that arises in depression because of pain comfort and the direct impact of tDCS on melancholy this trust research that displayed that tDCS may invert the unhealthy changes and return to the ideal condition within the widespread psychological patients.^[25] This agree with Brunoni *et al* ^[26] who concluded that tDCS may accelerate the anti-depression effects, especially if associated with various treatments .and agree with Knotkova *et al* ^[27] who found that tDCS may fasten the therapeutic effects more than other anti-depressors that takes prolonged time for the healing stage. Moreover, tDCS is considered as a desirable treatment for despair, mainly for people who cannot tolerate the negative impacts of antidepressants.

The end result of this study come in contrast to, Loo *et al* evaluated tDCS in the double-blind randomized study which included 40 outpatients with despair, treatment has changed into furnished for treatment for 5 sessions, three days weekly, anodal stimulation was supplied to the left dorsolateral prefrontal cortex (DLPFC) at 1 mA for 20 minutes, melancholy rankings advanced, there was no dissimilarity among active and sham stimulation.^[28]

Conclusions

The findings of this study suggested that tDCS is an effective modality for improving the overall quality of life in a patient with DPN as it has a significant effect in reducing neuropathic pain. Consequently, tDCS reduces anxiety and fatigue and improves upper and lower limb functions with a direct effect on applied cognition, general concern, and depression.

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Conflict of interest

The authors state no conflict of interest.

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