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Transcranial Direct Current Stimulation in Physical Therapy Practice: A Systematic Review

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Abstract

Introduction: Transcranial direct current stimulation (tDCS) is a non-invasive tool that induces neuromodulation in the brain. Day by day it is becoming very popular method of treatment in physical therapy practice to manage various neuromusculoskeletal condition. Therefore, the primary aim of this systematic review was to summarize the role of tDCS to manage various neuro-musculoskeletal conditions in physical therapy practice.

Methods: Following PRISMA guidelines, a computer-based literature search was conducted in four databases from 1996 to 2022 Randomized control trials were carried out that evaluated the effects of transcranial direct current stimulation (tDCS) on neuro-musculoskeletal conditions, including osteoarthritis, cerebral palsy, parkinsonism, spinal cord injury stroke, migraine fibromyalgia, low backache, etc. The qualities of the trials were assessed using the PEDro scale.

Results: Thirteen randomized control trials were included in this review. The results indicated that the tDCS significantly affects osteoarthritis, cerebral palsy, parkinsonism, spinal cord injury stroke, migraine fibromyalgia, and low backache when given with a combination of physical therapy interventions.

Conclusion: tDCS is found to be an effective intervention with good outcomes in participants when given in combination with physiotherapy in neuro-musculoskeletal disorders.

Keywords: Transcranial direct current stimulation, musculoskeletal conditions, systematic review, non-invasive brain stimuli, physical therapy

INTRODUCTION

The rise of chronic neuro-musculoskeletal disorders is becoming a global concern [1]. In physical therapy, transcranial direct current stimulation (tDCS) is emerging as one of the most promising techniques for treating various conditions. tDCS is a non-invasive, painless method that regulates cortical excitability. It uses weak direct current, which is applied through the scalp and can potentially develop neuroplasticity. Also, anodal stimulation enhances excitability, and cathodal stimulation decreases excitability. Several conditions have been found to be treated with tDCS, including osteoarthritis, cerebral palsy, parkinsonism, spinal cord injury, stroke, fibromyalgia, low backache, and temporomandibular disorders [2].

Chronic pain is a maladaptive response linked to decreased hippocampus neurogenesis [3] and ventromedial prefrontal cortex volume. It results in a reduced density of gray matter in areas of the cerebral cortex, such as the cingulated, insular, and dorsolateral motor cortex [3]. Other musculoskeletal disorders associated with neuroplastic changes distributed across the nervous system are chronic back pain, knee osteoarthritis (OA), etc. [4]. To counteract the maladaptive changes in plasticity, non-invasive brain stimulation, i.e., tDCS, has shown potential results. It changes pain circuits' membrane potential and maladaptive plasticity [5]. Anodal tDCS induces depolarization and excitability, whereas cathodal tDCS decreases the excitability of the neuronal membrane. The descending pain inhibitory pathway can be modulated top-down, using tDCS in areas involving descending inhibitory control [6].

The use of tDCS has been evaluated in different diseases like stroke, parkinsonism, mental illness, etc. [7]. Additionally, it improves emotional recognition of pain, descending pain inhibition, and endogenous opioid system modulation [8]. There are a few studies on tDCS's effectiveness in treating pain in musculoskeletal conditions, but there is no consensus on its use. It is a type of non-invasive brain stimulation acquiring several research perspectives. It uses low-frequency direct currents to stimulate the brain by placing electrodes on the scalp, but the stimulation area depends on the type of symptom the patient suffers [9, 10]. It has also been shown to control the intensity of chronic pain. Various studies available show the usage of transcranial direct stimulation in healthy volunteers, sports personnel, etc.

Furthermore, studies exhibiting favorable outcomes in patients with chronic pain by targeting the emotional component of pain and psychological issues like anxiety, depression, etc., are available [10, 11]. Transcranial effects with other physiotherapy interventions are still lacking in neuro-musculoskeletal disorders. Hence, our goal is to study the available literature to determine the sound effects of tDCS on neuro-musculoskeletal conditions and reduce patients' disabilities.

METHODS

Search strategy

A computer-based search was conducted using databases like PubMed, Scopus, Web of Science, and PEDro. The keywords used are tDCS, neurological conditions (cerebral palsy, parkinsonism, spinal cord injury stroke), musculoskeletal conditions (OA, fibromyalgia, low backache, etc.), and

physiotherapy interventions. The review followed the preferred reporting items for systematic reviews and meta-analysis guidelines.

Inclusion criteria

An inclusion criterion was organized using PICOS where the population included adult participants with neurological (cerebral palsy, parkinsonism, spinal cord injury stroke) and musculoskeletal conditions (OA knees, fibromyalgia, low backache, TMJ disorders) for 3 to 6 months, Intervention included tDCS or combined with physiotherapy, comparison included sham-controlled comparison or sham or combined with physiotherapy, Outcomes included the outcomes related to pain intensity and functional assessment, and Study design included randomized control trials (RCT). It also included a score of at least 5/10 on PEDro, the quality assessment scale, and studies written in English.

Exclusion criteria

Studies other than RCTs, other neurological conditions, musculoskeletal conditions, interventions performing other types of non-invasive brain stimulation, studies published as conference abstracts, dissertations, or in books, and studies where the participants in the control group were healthy.

Quality and risk of bias assessment

The RCTs' quality was assessed by the Physiotherapy Evidence Database (PEDro) scale. The scale has been found to have acceptable reliability and to distinguish between high and low-quality physiotherapy clinical trials. The scale includes 11 items about the methodological quality of the study, of which the scores of 9-11 are considered excellent quality, 6-8 good quality, 4-5 fair quality, and <4 poor quality.

Data collection

The authors reviewed the articles' titles and abstracts using the previously mentioned keywords to determine their appropriateness for this systematic review. Eligible articles were evaluated and scored using the PEDro quality assessment tool. If an article scored > 5/10 on the PEDro scale and met all other inclusion criteria, it was included in the review.

RESULTS

Study description and methodological quality

A total of thirteen randomized controlled trials were included in this review. The quality of the studies, regarding methodological strength, was evaluated through the PEDro scale. Most of the studies lay between good levels of evidence (Table 1) [12-25]. But, some of the studies having methodological weaknesses did not have a blinded therapist performing treatment [7, 13, 14]. The blinding of the subjects was not done in three of the studies. Other weaknesses failed to blind the assessors of the outcome measures and perform an analysis.

Table 1 Quality of evidence scored with the PEDro Scale.

Authors	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**TOTAL**
Ahn et al., 2017 [12]	1	1	1	1	1	1	0	1	0	1	1	7

Kim et al., 2022 [13]	1	1	1	1	1	1	1	0	0	1	1	9
Mendonca et al., 2016 [22]	1	1	1	1	0	0	1	1	1	1	0	8
Riberto et al., 2011 [23]	1	1	1	1	0	0	1	1	1	1	0	8
da Graca Trrago et al., 2019 [24]	1	1	1	1	1	1	1	1	0	1	0	9
Chang et al., 2017 [25]	1	1	1	1	1	0	1	0	0	1	1	8
Sajadi et al., 2020 [18]	1	1	1	1	0	0	1	1	0	1	0	7
Valle et al., 2009 [21]	1	0	1	1	1	0	1	1	0	1	1	9
Hazime et al., 2017 [20]	1	1	1	1	1	0	1	1	0	1	0	8
Belley et al., 2018 [19]	1	1	1	1	1	0	1	1	0	1	0	8
Oliveira et al., 2015 [17]	1	1	1	0	1	0	1	1	0	0	1	7
Fregni et al., 2006 [16]	1	1	1	1	0	1	0	1	0	1	1	8
Cha et al., [14]	1	1	1	1	0	0	0	1	0	1	0	7
Jensen et al., [15]	1	1	1	1	0	0	0	1	0	1	1	7

[A= Eligibility criteria for the study; B= Subjects were randomly allocated to groups; C= Allocation was concealed; D= The groups were similar at baseline for the most significant prognostic indicator; E= There was blinding of subjects; F= There was blinding of all therapists who administered the therapy; G= There was blinding of all assessors who measured at least one key outcome; H= Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups; I= Intention to treat analysis; J= Between-group statistical comparisons are reported for at least one outcome measure; K= Both point measures and measures of variability for at least one key outcome], "yes" was considered as 1 and "no" as 0.

Outcome measure assessment

The articles had various outcome measures. The outcome measures majorly used in the study were the Visual Analogue Scale (VAS), Numerical Pain Rating Scale (NPRS) and Functional disability scale, Electroencephalogram (EEG), Box and Block Test (BBT), grip strength test, and Fugl-

Meyer Assessment (FMA) scale in neurological and musculoskeletal conditions. The individual outcome measures used in the studies can be seen in Table 2 [12-25].

Table 2 Summary of Reviewed Articles.

Author's Name , year	Type of Study	Group intervention	Outcome measures	Result and conclusion	Limitations
Ahn et al., 2017 [12]	RCT	40 patients with osteoarthritis were randomly assigned into two groups (50-70 years) two groups. The first group received anodal tDCS to the motor cortex for 20 min at 2mA, and the second group received sham stimulation.	The primary outcomes were the numerical pain severity scale, WOMAC, and SF-McGill Pain rating scale.	This study's result revealed a significant improvement in pain and disability.	This study was single-centric with a small sample size. The long-term follow-up was not considered for the study.
Kim et al., 2022 [13]	RCT	25 participants (66- 86 years) with chronic musculoskeletal pain were randomly divided into two groups. The first group received anodal tDCS with physical therapy treatment and the second group received sham stimulation	Level of pain, daily physical activity, health-related quality of life survey, and depression.	The result of this study revealed the positive effects of tDCS in combination with physical therapy for the reduction of chronic musculoskeletal pain in the older adult.	This study was conducted during COVID-19 pandemic because of which the long term follow-up was not taken. Small sample size was another limitation.

		with physical therapy treatment three times per week for eight weeks.			
Cha et al., 2014 [14]	RCT	A total of 20 stroke patients aged 50-70 years were randomly divided into two groups. Both groups received basic functional improvement training for 30 minutes for five sessions per week, and the total duration was four weeks. tDCS was added in the experimental group for 20 minutes.	The outcome was measured by the Box and Block Test (BBT), hand grip strength and Fugl-Meyer assessment (FMA).	The experimental group showed better improvement in all the parameters.	Only subjective outcomes were taken for outcome measures.
Jensen et al., 2013 [15]	RCT (control sham)	30 individuals with spinal cord injury with minimum age above 18 years and twelve months post-injury. The participants were divided into two groups. The	For the pain assessment, Numerical Rating Scale (NRS) was used. EEG was used for the evaluation of brain activity	The experimental group showed significantly better findings for the non-pharmacological management on pain and brain activity	EEG was measured 20-30 minutes before and after the treatment and not during the treatment.

		experimental group received tDCS along with other conventional therapy. The control group received sham tDCS.			
Fregni et al., 2006 [16]	RCT (sham-controlled)	32 female patients with fibromyalgia (40 – 60 years) were divided into two groups to receive sham stimulation or real tDCS with anode centered over M1 or dorsolateral prefrontal cortex 2ma for 20 mins for five days	Visual analog scale, fibromyalgia impact question form, short form 36 Health survey, safety assessed	The primary motor cortex anodal stimulation significantly improved pain compared to the sham and dorsolateral cortex. It was beneficial in fibromyalgia	The safety measurements were not assessed in the study
Oliveira et al., 2015 [17]	Blind RCT	32 patients aged 18 – 40 after evaluation were divided into two groups. They underwent 4 weeks protocol of exercises and manual therapy together with active or sham primary motor cortex tDCS	TMJ criteria, pain intensity, pain pressure threshold over TMJ, cervical muscles, and quality of life	Reduction in pain intensity and pain pressure threshold but without significant difference between the groups. The study shows no benefits of tDCS to the exercises	Lack of control and blinding group

		with 2 mA for 20 mins daily for 5 days			
Sajadi et al., 2020 [18]	Double-blind RCT	40 patients aged 51- 70 were randomly assigned to the Transcutaneous electrical nerve stimulation (TENS) group20 and tDCS group20. TENS following parameter freq 100 Hz, pulse width 100ms, the intensity of 10 percent below the patient motor threshold for 25 min, and tDCS at 2mA for 20 mins up to 6 sessions	VAS, WOMAC	Both the TENS and tDCS groups exhibited significant improvements at each follow-up.	The limitations were a limited follow-up period of 3 months and a lack of sham group
Belley et al., 2018 [19]	RCT (Triple Blind Trial)	40 patients with tendinopathy were randomized into two groups.	DASH And Western Ontario Rotator Cuff (WORC) index was used for all participants in the 3^{rd}, 6^{th}, and 12^{th} week	Significant improvement in all the parameters for both groups in the 3rd, 6^{th}, and 12^{th} week. The results did not show any improvement in outcomes with the addition of	The evaluation of cortical excitability was done before and after the initial physiotherapy. Moreover, no treatment group was included in the study

				tDCS during the rehab program	
Hazime et al., 2017 [20]	RCT (double-blind factorial trial)	92 subjects with chronic non-specific back pain aged 18-65 were divided into 4 groups, real tDCS + real Peripheral electrical stimulation (PES), real tDCS + sham Peripheral electrical stimulation, sham tDCS+ real Peripheral electrical stimulation, sham tDCS +sham PES for four weeks, 3 sessions per week	Numerical pain rating scale, GROC before and after treatment and four weeks, 3 and 6 months post division in the group	Decreased pain scores with transcranial direct stimulation and PES and not only of tDCS	Sub-group evaluation was not done. Patient satisfaction was mainly achieved, which reflected in the results
Valle et al., 2009 [21]	RCT (sham-controlled longitudinal study)	41 female patients with mean age 54, and with chronic fibromyalgia were divided into two groups of treatment involving 10 sessions of 2 mA, 20 min tDCS of M1 or	VAS, quality of life, back depression inventory, Geriatric depression scale, a mini mental scale for safety	Motor cortex and Dorsolateral prefrontal cortex stimulation have improved VAS and quality of life. The study suggests the importance of the long duration of the treatment period suggesting 10	Limitation of the study not found

		dorsolateral prefrontal cortex, follow-up assessment for three and six months		daily sessions' result is more long-lasting	
Mendonca et al., 2016 [22]	RCT (placebo-controlled)	45 fibromyalgia individuals (18-65 years) were divided by blinded therapists into 3 groups, tDCS + aerobic exercises, aerobic exercises, and tDCS alone for 4 weeks. The first-week tDCS sessions consisted of 5 days (Monday to Friday) coupled with aerobic exercises. The assessment was done before and after one week and for one to two months	NRS, Pain Pressure Threshold (PPT), quality of life	The result of this study exhibited that neuro-modulation with tDCS in combination with aerobic exercises reduces pain intensity than single techniques and has a greater effect on behaviour in fibromyalgia patients	There is no limitation
Riberto et al., 2011 [23]	Double-blinded randomized control trial	23 fibromyalgia individuals (18 to 65 years) were divided into active and sham-controlled groups. tDCS	The pain was evaluated with VAS, and SF-36 was used to measure the health-related quality of life.	This study showed that tDCS, combined with other physical therapy approaches, reduced pain and improved	Less sample size resulted in fewer improvements in other outcome measures. Due to short-term

		was used with other physical therapy in the active group.	Two questionnaires were used, one for fibromyalgia evaluation and another one for general health assessment.	health-related quality of life.	follow-up, long-term effects of tDCS could not be found
da Graca Tarrago et al., 2019 [24]	RCT	60 women (50-70 years) were randomly divided into 4 groups, a tDCS and aEIMS-15, a tDCS and s SEIMS-15, st DCS and aEIMS-15, s tDCS and s EIMS-15 at 2 mA 20 minutes, 5 session	PPT, VAS, WOMAC	It resulted in improved clinical effects in pain measures and decreased pain inhibitory control when the neuromodulation of the primary motor cortex with tDCS was combined with bottom-up modulation with intramuscular electrical stimulation in knee OA	Few concerns in the design of the study. When they were asked about tDCS use, <12 % of patients guessed Intervention correctly. We found immediate pain relief, which led to more sessions with long-lasting results
Chang et al., 2017 [25]	Pilot randomized control trial	30 subjects (50-65 years), n-15 active tDCS and exercises, n-15 sham tDCS and exercises twice weekly for 8 weeks, home exercises for knee twice/week	PPT, conditioned pain modulation, heat pain threshold, WOMAC	First research and safety measurement in combination with tDCS to quads strengthening exercises for knee OA. Active tDCS improved pain to function. A large random	Small sample size, short follow up

				RCT sample with longer follow-up is evidence of the clinical benefit of this beneficial treatment for knee OA	

Interventions

Surface electrodes of 35 cm^2 were used to deliver tDCS. The active electrode (anode) was placed over M1 contralateral to the affected knee and the reference electrode (cathode) over the contralateral supraorbital region for 20 mins at 2 mA in the osteoarthritis knee for five sessions. The current ramped up and down at the beginning and end of most studies (0 mA – 1 mA, 1 mA – 0 mA) [10-12]. The intensity was 1 ma and 1.5 mA for about 20 – 30 mins for a few studies [16]. The anode was placed at C3- C4 of the motor cortex contralateral to the temporomandibular joint, while the cathode was over the opposite supraorbital area [17]. One study revealed the electrode placement on the dorsolateral prefrontal cortex on F3 [13]. The sham stimulation was placed at an identical position, where the current ramped for 30 sec for about 20 mins. Various studies have varied treatment sessions [5, 10, 12]. Two studies were applied separately and independently [7, 14]. Furthermore, seven studies combined tDCS with peripheral electrical stimulation, cognitive behavioral therapy, strengthening exercises, aerobic exercises, sensorimotor training, and intramuscular electrical stimulation [9, 10, 12].

The effects of tDCS on pain

Most research used anodal stimulation over the M1 area. However, four studies demonstrated a significant decrease in the visual analog and numerical pain scales when paired with other physiotherapy interventions as opposed to sham tDCS [7, 10, 13, 16]. Five studies reduced VAS Scores, but no significant differences were found [8, 10, 12, 14, 17]. However, only two studies found no improvement in pain scores [9, 15]. Compared to the beginning of treatment, the pain pressure threshold decreased.

The effects of tDCS on function and disability

The improvement in physical function and mobility was observed in many studies, which was assessed by the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score [10-12]. The early improvement in WOMAC score was not significant in the first follow-up but improved significantly in the 2^{nd} and 3^{rd} follow-up [14]. The SF-36 Fibromyalgia Impact Questionnaire (FIQ) used in fibromyalgia reported a decreased score as compared to the baseline and other groups [7, 8, 13]. Two studies used the Roland Morris Disability Questionnaire (RMDQ) to assess disability which did not show any significant improvement in RMDQ after the application of anodal tDCS over the M1 region [9, 16], the quality of life [9], and Disabilities of the Arm, Shoulder, and Hand Questionnaire (DASH) score [15].

The effect of tDCS on other physical therapy interventions

A thorough literature search revealed that tDCS could be used in combination with other physiotherapy exercises or modalities to treat neuromusculoskeletal conditions like cognitive behavioral therapy in non-specific backache (Fig. 1) [9], TMJ exercises, knee OA, peripheral and functional electrical stimulation, and aerobic exercises [13, 17]. Other than chronic back pain and temporomandibular disorders, the combination of fibromyalgia and knee OA has shown the best outcomes. There is no benefit to adding tDCS to TMJ exercises. However, adding tDCS with strengthening exercises has shown pain reduction and positive outcomes in the patient's functional capacity.

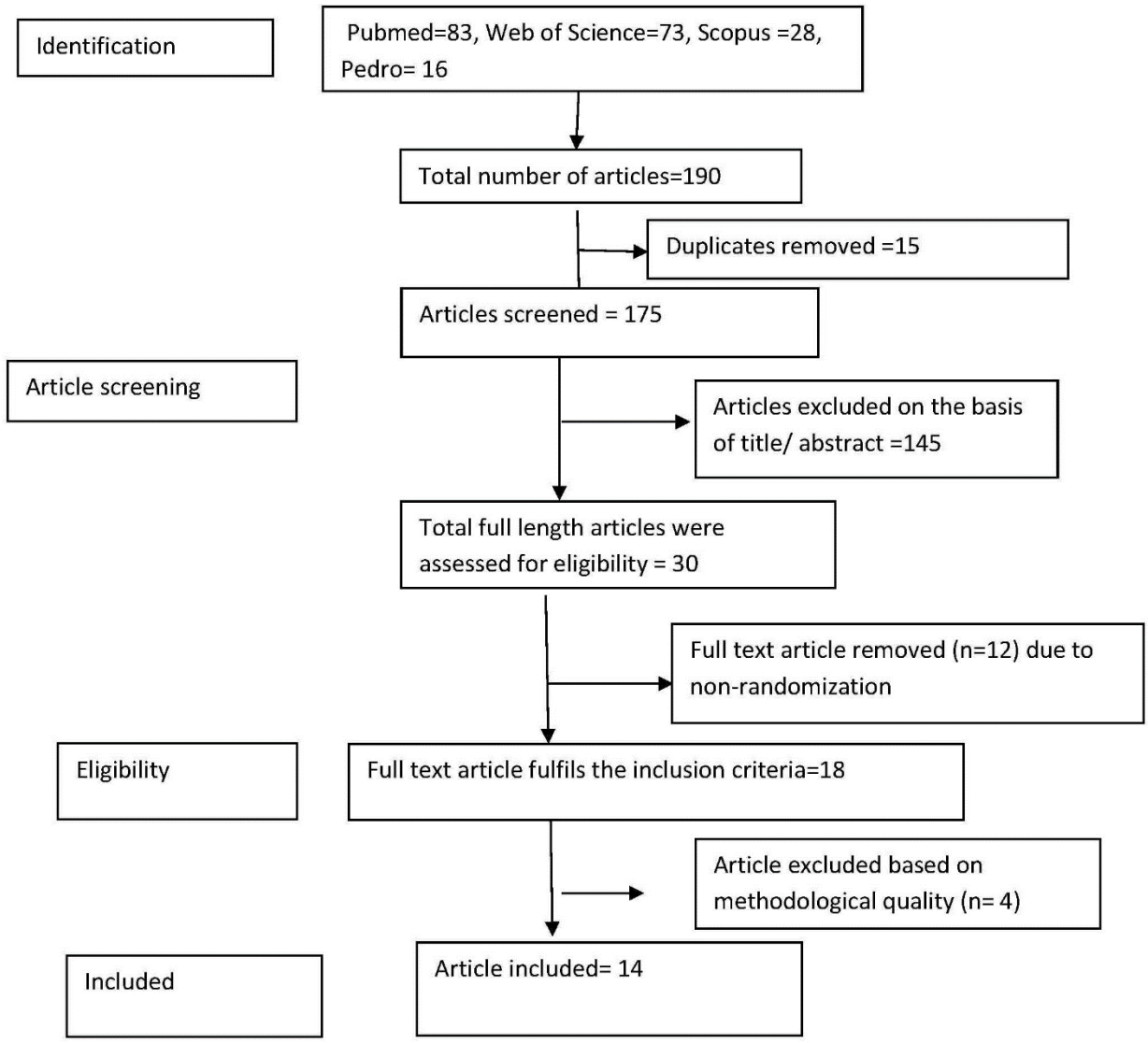

Fig 1. A flow diagram for the literature search.

Using tDCS with bottom-up modulation with electrical muscle stimulation in knee OA, there was an improvement in pain and descending pain inhibitory control [8]. The quality of life has also

improved after using tDCS with aerobic exercises and peripheral electrical stimulation for a longer duration, measured with scales like the disability scale and global perception scale [13, 16]. Cha et al. (2014) conducted a study where 20 stroke patients aged 50-70 were randomly divided into two groups. Each group received basic functional improvement training five times per week for four weeks for 30 minutes. The experimental group, in addition, received tDCS for 20 minutes. In this study, the experimental group showed significant improvement in BBT, hand grip strength, and FMA [22]. Another sham control study conducted by Jensen et al. (2016) revealed significantly better findings for the non-pharmacological management of pain and brain activity using tDCS [23].

Adverse effects

A questionnaire was given to participants after treatment sessions to report any adverse effects. Two studies noted a single episode of headache and painful sensation [12, 16]. Some studies reported skin redness, itching, tingling, mood changes, and difficulty concentrating [7, 10, 12, 16]. Four studies found that the Intervention had no adverse effects on participants.

DISCUSSION

The primary objective of this review was to determine the effects of tDCS on various neuro-musculoskeletal disorders. Thirteen randomized control trials were included. This literature review revealed that, combined with other traditional physical therapy, tDCS had demonstrated improvements in pain and functional abilities in various neuro-musculoskeletal disorders. Positive outcomes were observed in articles related to disorders other than chronic back pain, like knee OA, stroke, spinal cord injury, and fibromyalgia [12-25]. Anode electrodes were placed in the primary motor cortex and dorsolateral prefrontal cortex, and cathode electrodes were placed in the contralateral supraorbital area [26, 27]. Exercises prescribed in the research articles include strengthening exercises, sensorimotor training, and aerobic exercises; some have shown positive results in patients' functional and pain scores. A sham stimulation is applied to the same area, with the current ramping up and down for 30 seconds before being switched off for 20 mins. However, anodal tDCS is more effective than sham tDCS [5, 6, 16, 19].

Through priming, anodal electrode placement on the primary motor cortex in combination with a strengthening protocol for knee OA has boosted strength, motor control, and muscle coordination by increasing cortical excitability [19]. Thus, the reviewed articles proposed improved patient performance results.

Studies examining the tDCS effects with or without physical therapy modalities, such as peripheral and functional electrical stimulation (PES), and intramuscular electrical stimulation (IMES), have shown positive results in disorders like knee OA and fibromyalgia. Still, the effects of tDCS alone have not been examined [20, 21]. Future studies should explore the tDCS individual effects over longer periods. Five sessions of tDCS have been considered less effective than stimulation given for more sessions [23]. The pain evaluation was done using VAS and the numerical pain rating scale, and it found that tDCS reduced pain scores in most articles. The disability was assessed using scales like Western Ontario and McMaster Universities Osteoarthritis index, fibromyalgia assessment scale, and Roland Morris disability scale, resulting in improved patient functional

abilities [21-25]. Marked reduction in pain pressure threshold has been seen in some studies related to osteoarthritis [12, 18]. The safety of the patients was assessed using a questionnaire after giving treatment; only a few side effects were seen in patients, and was evident that it is harmless for the patients. A study was conducted by Cha et al. (2014) where 20 stroke patients aged between 50-70 years were randomly divided into two groups. Both groups received basic functional improvement training for 30 minutes for five sessions per week for four weeks. The experimental group additionally received Tdcs for 20 minutes. In this study, the experimental group showed significant improvement in Box and Block test (BBT), hand grip strength, and Fugl-Meyer assessment (FMA) [12]. Another sham control study conducted by Jensen et al. (2016) discovered that the tDCS showed significantly better findings for the non-pharmacological management of pain and brain activity [15].

Although anodal transcranial direct stimulation has shown short-lasting results, few studies proposed that 10 sessions have resulted in better clinical outcomes. Quality of life has improved with tDCS in the conditions like osteoarthritis knee and fibromyalgia [21-23]. But, evidence is still lacking in the conditions like temporomandibular disorders, rotator cuff tendinopathies, and non-specific backache. For tDCS in clinical practice in these conditions, further research is needed with large sample size. tDCS has shown significant results together with other physical therapy interventions in neuro-musculoskeletal conditions.

Clinical relevance

According to this review, combining tDCS with other physical therapy interventions resulted in better pain reduction and functional ability in various neuro-musculoskeletal conditions than tDCS alone. It is a promising modality that physiotherapists can use to treat patients.

STRENGTHS AND WEAKNESSES OF REVIEWED ARTICLES

It can be challenging to assess the included articles, determine their strengths and weaknesses, and choose which ones provide the strongest evidence. It is crucial to evaluate the methodological quality. Table 1 lists the strengths of the articles. These articles had the following strengths: eligibility criteria, random allocation, and statistical analysis between groups for outcome measures. The articles in this review with the highest methodological quality received PEDro scores of 8 out of 10 [9, 12]. The only areas of weakness were the lack of blinding of treating therapists and the failure to perform an intention-to-treat analysis. Overall weakness included blinding the subjects with a lack of assessors in some studies. Another weakness in several articles was the failure to report effect sizes for all the variables included. An elaborative presentation can be seen in Table 1.

LIMITATIONS

Although the included articles had some solid findings, they also had a few limitations. There weren't many articles available that were relevant to the review topic. Individual effects of tDCS were not mentioned. Other limitations included small sample size, inadequate follow-up, absence of blinding, and the failure to evaluate other safety measures in some studies. More sessions are required to demonstrate more long-lasting effects of tDCS. Additionally, only articles written in

English were included, and the search strategy may have limited the amount of literature to be included. Thus, the results may not reflect all the current literature on tDCS.

CONCLUSION

Based on the results of this systematic review, tDCSis an effective treatment for neuro-musculoskeletal disorders when combined with physiotherapy. However, due to the lack of literature and the limitations of the articles, more research trials with larger sample sizes should be conducted to find its effects on neuro-musculoskeletal conditions.

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