ABSTRACT

Transcranial direct current stimulation (tDCS) has been addressed in several studies due to presenting benefits in the post Vascular Accident (CVA) patient who mostly features sequelae associated to functional and motor control deficit, justifying physical therapy in all phases of the rehabilitation process. This study has the objective of assessing the effects of several physical therapy techniques combined with tDCS in post stroke patients. Bireme, PubMed, and Cochrane databases indexed 2010-2015 clinical trials and randomized controlled trials into English were taken into account. We have found 216 articles and then selected 10 accomplishing the inclusion criteria, which addressed Conventional Physical Therapy, Containment Induced Therapy, Virtual Reality and Robotics techniques. All of the articles reported improvement based upon the addressed techniques during physical therapy, beyond even more significant gains when associated with tDCS.

Keywords: stroke, transcranial direct current stimulation, physical therapy

RESUMO

A Eletroestimulação Transcraniana por Corrente Contínua (ETCC) tem sido abordada em diversos estudos por apresentar benefícios no paciente pós Acidente Vascular Encefálico (AVE), que apresenta em sua maioria, sequelas associadas a um déficit funcional e no controle motor, justificando a Fisioterapia em todas as fases do processo de reabilitação. Este estudo apresenta o objetivo de avaliar os efeitos das diversas técnicas fisioterapêuticas combinadas com a ETCC em pacientes pós AVE. Foram considerados ensaios-clínicos e ensaios clínicos randomizados indexados nas bases de dados Bireme, Pubmed, e Cochrane entre 2010 e 2015, em inglês. Foram encontrados 216 artigos e selecionados 10 por suprirem os critérios de inclusão, que abordavam as técnicas de Fisioterapia Convencional, Terapia de Contenção Induzida, Realidade Virtual e Robótica. Todos os artigos relataram melhora com as técnicas abordadas durante a fisioterapia e ganhos ainda mais significativos quando associados à ETCC.

Palavras chave: acidente vascular cerebral, estimulação transcraniana por corrente contínua,
1. INTRODUCTION

Accordingly World Health Organization (WHO), stroke is defined as a fast symptoms and clinical signals development from a focused (or global) disturbance at brain function for more than 24 hours or that may lead to death without any other apparent cause besides vascular one. It is one of the main morbidity and mortality causes all over the world, related to elevated disability levels at long term.¹

Most cerebrovascular diseases might be linked to hypertension and atherosclerosis, which is the main responsible one for ischemic strokes (IS).²

After a stroke, nearly 50-70% of the patients are able to return to be functionally independent, and 15-30% progress along with some disabling sequel. Among neurological post stroke sequelae we may quote sensory-motor, muscle and bones, perceptual and cognitive alterations. Thinking of motor sequelae, hemiparesis (one body side weakness) is the most frequent one after stroke.¹,²

Physical therapy is essential and imperative in this health condition rehabilitation, and must act from the first moment throughout all the phases of the process, what demands its presence in any type of stroke treatment or at any health care station. There are preliminary evidence that both the abilities acquisition for normal individuals as much as the functional improvement for stroke survivors are related to cortical motor excitability improvement.³

Transcranial Direct Current Stimulation (tDCS) is a painless noninvasive method where neuromodulation occurs without neuronal depolarization, and consists in modifying cortical excitability into an Anodic (excitatory effect, stimulating injured ipsilateral hemisphere) or a Cathodic way (inhibitory effect, inhibiting injured contralateral hemisphere due to allow ipsilateral to work).⁴

Studies have been utilized tDCS in association with several physical therapy approaches aiming to better assess a patient’s clinical improvement. Therefore, the objective of this study consists in assessing diverse physical therapy effects combined to tDCS in post stroke patients.

2. METHODS

A literature review has been performed over Bireme, PubMed and Cochrane databases upon the following descriptors into English language: stroke; transcranial direct current stimulation; physical therapy.
Inclusion criteria considered controlled trial and randomized controlled trial indexed articles published 2010-2015, and associating tDCS and Physical Therapy as intervention for treatment of post stroke patients. Literature review articles and those adopting another brain stimulation technique were excluded from this study.

3. RESULTS

An initial amount of 216 was found (Figure 1), and 10 of those have been selected due accomplishing of all the inclusion criteria. From those, the mainly quoted techniques were Containment Induced Therapy (CIT), Virtual Reality, Robotics and Conventional Physical Therapy compounded of kinesiotherapy and functional training mostly based upon daily life activities.
<table>
<thead>
<tr>
<th>AUTHOR</th>
<th>SAMPLE</th>
<th>INTERVENTION</th>
<th>PHYSICAL THERAPY</th>
<th>TESTS</th>
<th>CONCLUSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lindenberg R, et al., 2010</td>
<td>n = 20</td>
<td>GE: tDCS (Cathodic and Anodic) (30min) + FC (60min); GC: Placebo tDCS (30s) + FC (60min)</td>
<td>Functional motor tasks to promote sensory-motor stimulation and coordination.</td>
<td>FMS, WMFT</td>
<td>There was a larger motor function improvement for GE in both scales.</td>
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<tr>
<td>Bolognini N, et al., 2011</td>
<td>n = 14</td>
<td>GE: Cathodic and Anodic tDCS (40 min) + CIT (4 h/14 days)</td>
<td>Nine tasks: Pour water in a bottle (4min); Write (10min); Feed oneself using a spoon (4min); Turn pages (4min); Screw a simple structure with a screwdriver (6min); Same task, with a complex structure (6min); Fold napkins (3min); Button up a shirt (4min); Roll dice (4min).</td>
<td>JTHFT, HS, MALS, FMS</td>
<td>Both groups presented tests improvements. However, Active tDCS Group achieved greater gains.</td>
</tr>
<tr>
<td>Study</td>
<td>Authors</td>
<td>n</td>
<td>Intervention</td>
<td>Outcome</td>
<td>Notes</td>
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<tr>
<td>Lindenberg et al., 2012</td>
<td>GE: tDCS (30min) + Physical Therapy / Occupational Therapy (60min)</td>
<td>10</td>
<td>Functional motor tasks aiming to promote sensory-motor integration, movement coordination, and tasks focused to the patients’ daily life activities</td>
<td>Results confirm tDCS both hemispheres efficiency, combined with sensory-motor stimulation.</td>
<td>Authors do not clearly describe the adopted techniques.</td>
</tr>
<tr>
<td>Wu D, et al., 2013</td>
<td>GE: Cathodic tDCS (20min) + Conventional Physical Therapy</td>
<td>90</td>
<td>Included good positioning of the limb maintenance, stretching, physical therapy modalities and techniques, and mobilization training for 30min, twice a day. Authors do not clearly describe the adopted techniques.</td>
<td>Scales scoring better improved for the Group combining Conventional Physical Therapy and tDCS.</td>
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Physical therapy in post stroke patients who underwent transcranial direct current stimulation: literature review

Giacobbe V, et al., 2013

GE: Anodic tDCS (20min) + Robotic Motor Training (20min)
GC: Placebo tDCS (20min) + Robotic Motor Training (20min)

The robot (InMotion3) has been utilized for wrist mobilization: Radioulnar deviation, and curl and extension. Passive stretching at curl and extension has been performed by the robot in the beginning of the sessions, The robot provided active mobilization without any resistance, and the patient had a visual feedback of the aimed target.

Ochi M, et al., 2013

Group A: Anodic tDCS + Robotic Therapy for 5 days, 2 days pause, then Cathodic tDCS + Robotic Therapy
Group B: Cathodic tDCS + Robotic Motor therapy for 5 days, 2 days pause, then Anodic tDCS + Robotic

Both presented significant improvements at FMUL and MAS, but not at MAL. Spasticity improved after Cathodic tDCS + Robotic Therapy for right hemisphere injuries, but not for left hemisphere injuries.

Scoring improved when tDCS was delivered before robotic training.
Physical therapy in post stroke patients who underwent transcranial direct current stimulation: literature review

Viana R, et al., 2014

GE: Anodic tDCS (13min) + VR; GC: Placebo tDCS (13min) + VR (1h/15 sessions)

Stretching before and after VR in both upper limbs.

Three Nintendo Wii games adopted as VR:
- “Wii Sports ResortTM”
- “Wii Play MotionTM”
- “Let’s TapTM” (15min each) addressing shoulder, elbow, wrist and fingers movements (3x/week, 5 weeks).

There were no significant differences between groups concerning motor function.

Wrist flexors spasticity improved at GE.

RV compounded by 3 games:
- “Bird and Ball”, where the patient touched a ball upwards;
- “Conveyor”, consisting in moving a box from a container to the opposite side;
- “Juggler”, consisting in picking and tossing up a ball

Lee S, et al., 2014

Group A: Cathodic tDCS; Group B: VR; Group C: Cathodic tDCS and VR simultaneously.

15 sessions, 5x/week 30min/day

MAS, MFT, FMS, MMT, Korean-Modified Barthel Index, Box and Block Test.

Group C presented better FMS and MFT scoring.

Associating tDCS and VR shall compound a useful method to improve paretic limb recovery.
Physical therapy in post stroke patients who underwent transcranial direct current stimulation: literature review

Rocha S, et al., 2015

<table>
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<tr>
<th>Group A: Cathodic tDCS (9min) + CIT (1h); Group B: Anodic tDCS (13min) + CIT (1h); Group C: Placebo tDCS (30s and turn off) + CIT (1h)</th>
</tr>
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<tbody>
<tr>
<td>During CIT therapy, patients were submitted to 1h of intensive fine and Gross motor function training. Tasks were not described. Patients were instructed to let the non paretic limb immobilized 6h/day for four weeks during daily life activities.</td>
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</table>

Outcomes showed better improvement of patients’ motor function when CIT was combined to Anodic tDCS.

Sik B, et al., 2015

<table>
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<tr>
<th>Group A: tDCS anodic (20min) + Conventional Physical Therapy (2h); Group B: tDCS both hemispheres (40min) + Conventional Physical Therapy (2h); Group C: tDCS placebo (1s) + Conventional Physical Therapy (2h); 15 sessions.</th>
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<tbody>
<tr>
<td>Mobilization, strengthening, and sensitization, accordingly each patient needs. Activities to improve supination and adherence release. Sets and repetitions were not described, neither was specified the execution of every technique.</td>
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</table>

The authors observed significant improvements and scoring for Groups A and B, concluding tDCS associated to conventional physical therapy promotes functional motor gains to the patient.

4. DISCUSSION

Among post stroke sequelae, hemiparesis drives to the most common one, leading the patient to a body side functional loss and consequent quality of life decrease. It is well known the importance of intensive and repeated movement practice due to promote the affected limb recovery. Motor learning and physical therapy have this important role, besides inducing plasticity and re-learning of the lost movement. Studies have demonstrated that through neuromodulation tDCS may modify the membrane potential with no depolarization, and modulate ionic channels either increasing or decreasing cortical excitability. Both techniques influence neuroplasticity and for that matter tDCS in association to several physical therapy techniques has been addressed. 5,6

Lindenberg et al.,1,3 utilized Anodic and Cathodic tDCS simultaneously along with Conventional Physical Therapy and Occupational Therapy, describing a motor functional tasks protocol for sensory-motor stimulation and coordination promotion, such as reaching, picking, and manipulating objects. They observed a synergetic effect when summed the cortical excitability simultaneous modulation and the physiotherapy sensory-motor stimulation, improving more significantly motor control and plasticity according WMFT scale.

Lindenberg et al., 3 applied a 5 consecutive days procedure, 29 days pause, and then repeated the same procedure, obtaining better FMS and WMFT scales outcomes. Otherwise, the first application bout achieved larger outcomes in both scales.

Wu et al.,4 utilized a physical therapy practices cluster including good positioning of the limb, stretching, and movement training 30min/session, twice a day, five days a week during four weeks, associating Cathodic tDCS. They observed muscle tone decrease and motor function improvement.

Sik et al.,10 utilized conventional physical therapy compounded by mobilization, strengthening, and sensitization, besides activities for supination improvement and adherence release accordingly each patient needs, over 15 sessions, 2h each one, adding Anodic tDCS to a group of patients, and Anodic and Cathodic tDCS to another one. Their objective consisted in increasing recruiting at the ipsilateral injured hemisphere and decreasing neuronal activity at the contralateral (non-injured) hemisphere. However, none significant differences were noticed in motor function brain stimulations comparison. Sets and repetitions were not described neither specified the physical therapy adopted protocol.

Bolognini et al.,2 proposed Anodic and Cathodic tDCS and CIT use as a physical therapy treatment. That option was made upon the fact CIT either objectives decreasing the non-impaired motor cortex activity, and increasing injured motor cortex activity.
The patient was to execute the proposed tasks wearing a glove in the non-paretic limb, built with a resting splint attached to a sling in order to avoid any movements. The glove was also worn by the patient at his home nearly 90% of his/her wake time, during 14 days. Outcomes show CIT led to a corticospinal excitability decrease in the non-injured hemisphere. For the tDCS in both hemispheres group, there was noticed transcallosal inhibition increase and corticospinal excitability increase at the injured hemisphere.

Rocha et al.,9 oriented their patients for the use of the glove 6h/day, during four weeks, as they received intensive training for fine and gross motor function 1h/day, thrice a week. Their study subjects sample was divided into three groups: Anodic and CITm; Cathodic and CITm; and CITm. They concluded motor gains were larger when CITm have had been associated to Anodic tDCS.

Lee et al.,8 divided a subjects sample into three groups. The objective was to assess separately the effects of Cathodic tDCS, VR, and both simultaneously over 15 sessions of 30min each, 5days/week. The paretic limb wore a glove able to transmit the movements performed by the patient to the virtual system, enabling him/her to see his/her movements in real time, promoting motivation through the virtual environment during the games proposed by the physical therapist. They concluded that when used separately, VR seemed to be more efficient as a treatment, although when associated simultaneously there were noticed even more significant differences, showing both techniques together shall be a useful method to improve motor recovery.

Studies show that VR games technology allows patients to interact with a virtual environment through a movement screening system, sensors and wireless control. Also, recreational game encouraging movements may improve motor function.

Viana et al.,7 besides VR, utilized the stretching of the limb thrice a week for five weeks, and divided their subjects sample into two groups, both performing Nintendo Wii Gaming System therapy, and one of them performing only tDCS treatment. Both groups presented gains in all assessed areas, except for the SSQOL-UL scale. Significant differences were reported only concerning wrist spasticity.

Ochi et al.,6 also noticed spasticity improvement with the use of robotic therapy combined to Cathodic tDCS for right hemisphere injuries, and a significant FMUL and MAS improvement. Their protocol consisted in a Bi-Manu-Track Robotic Arm Trainer, which performed pronation/supination and curl/extension passive and active-assisted movements.

Giacobbe et al.,5 also opted for Robotic Therapy with InMotion3 Robot, able to perform wrist movements in radioulnar deviation and curl/extension, besides passive stretching under curl/extension before every session. During therapy, the robot provided active mobilization, and the patient had a visual feedback of the aimed target. After their assessments, there was observed an improvement in the motor performance only when tDCS was applied previously the robotic therapy.
5. CONCLUSION

All of the articles reported improvement of the motor control when the addressed techniques of physical therapy have had been applied isolated in placebo groups, pointing out the diverse physical therapy techniques are indispensable in the post stroke treatment.

When the authors associated tDCS to another physical therapy technique, patients presented even more significant improvement, showing that such association provides motor response improvements.

The articles poorly described the adopted physical therapy protocols, focusing mostly on tDCS application protocols.

6. REFERENCES