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TRANSCRANIAL DIRECT CURRENT STIMULATION (TDCS) AND VISUAL STIMULATION (VS) FOR VISUAL FIELD RESTITUTION AFTER STROKE: CASE REPORT

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ABSTRACT

The visual field is fundamental for the construction of human perception. Despite this understanding, its evaluation and treatment remain forgotten during the process of functional rehabilitation in individuals with neurological injury. There is still no consensus on the forms of treatment that can be used. Therefore, it was observed the importance of exposing the results of a case in which a patient was submitted to a protocol with Transcranial Direct Current Stimulation (tDCS), associated with Visual Stimulation (VS) for restitution of visual field lost after Ischemic Stroke (IS). The intervention lasted 90 days, with two intensive protocols of 15 days (with daily sessions) and weekly maintenance sessions for two months, which was the interval between each intensive protocol. After the intervention, partial restitution of the affected visual field was observed, as well as an improvement in the result in the execution of the activities presented as the main complaint, in addition to the evolution of the situation of insufficiency of adjacent convergence. It was possible to verify that an intervention protocol with tDCS, associated with VS, could promote positive effects in relation to the restitution of the visual field in an adult patient after stroke, providing improvement in quality of life and in the execution of activities of daily living.

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INTRODUCTION

Stroke is the leading cause of disability, inabiliy and mortality around the world (Esenwa; Gutierrez, 2015) and causes neurological dysfunctions as a consequence of lesions in the Central Nervous System (Cecil, 2005). Among the most characteristic symptoms of the clinical picture after stroke, the following stand out: alteration of the level of consciousness, speech and communication disorders, loss of global motor functions, with emphasis on one side of the body, gait alteration, postural control, balance and motor coordination, as well as visual and/or oculomotor dysfunctions (Nadruz, 2009). It is estimated that the visual system is affected in about 20 to 57% of cases (Pollock *et al*., 2011) after stroke. However, despite being considered one of the most complex and important systems for the construction of human perception, it is somewhat forgotten during processes of qualification and functional recovery of individuals with neurological injury (Kleiner *et al*., 2011). Visual field defects are one of the types of visual dysfunctions that can occur after stroke and end up affecting functional capacity in activities of daily living (ADL's), such as crossing busy streets or driving a car. The therapies described to date for the treatment of visual field losses aim at the restitution of the visual field, compensation of the visual field defect or "substitution" of the affected visual field (Pollock *et al*., 2011). According to the literature on the subject, restitutive interventions consist of visual field stimulation training, contrast sensitivity training and fusional training (binocular vision). Compensatory interventions are based on the training of saccadic eye movements, training in visual search strategies, training of eye movements for reading and training in activities of daily living. On the other hand, the substitutive interventions are carried out through the use of prisms, eye plugs, adapted lighting and environmental modification (Pollock *et al*., 2011). Recently, there has been a possible positive effect on the association between restitutive techniques and the use of noninvasive neuromodulation through Transcranial Direct Current Stimulation (tDCS) (Plow *et al*., 2012; Vanni *et al*., 2010; Gall *et al*., 2015). tDCS is a technique that involves the application of low intensity electrical currents (1 and 2 mA) through electrodes fixed to the skull, with the objective of altering the excitability of the underlying cortical neurons, inducing changes in brain activity and cortical functional connectivity (De Lara; Scortegagna, 2021; Max *et al*., 2020). The search for solutions to the dysfunctions presented after brain lesions guide the development of physiotherapeutic action, whereas the functional limitations imposed by these lesions severely impact performance in activities of daily living. There is also concern about the sum of the deficits associated with aging, since survivors of neurological lesions, day by day, will go through this process, which usually causes progressive changes in aspects such as balance, strength, eye movement and visual acuity. With these bases and understandings, this case report aims to expose the efficacy of an intervention protocol with VS-associated tDCS in an adult with visual field loss after stroke. Considering that there is still no consensus on the forms of treatment that can be used, the result found is extremely relevant.

CASE REPORT

A 30-year-old male patient, teacher, with clinical diagnosis of Ischemic Stroke, according to the International Classification of Functionality, Disability and Health (ICF), presented moderate dysfunction in "visual field functions (b2101.3)", proven by campimetry examination, with clinical characterization of the upper left quadrantopsia. In addition, in the oculomotor examination, there was insufficient convergence. His main complaint was difficulty in driving, reading and performing electronic leisure activities. Magnetic Resonance of the brain and orbits after the ischemic event revealed alteration of the right occipitotemporal corticossubcortical signal, compatible with acute ischemic insult in the posterior territory with the presence of right vertebral artery tapering, suspicious findings for arterial dissection. Furthermore, there was an expansive, extra-axial lesion in the left internal auditory canal, a probable lesion with the origin of a neural sheath (Schwanomma).

INTERVENTION

The intervention was performed by a multidisciplinary team in a simultaneous face-to-face modality with Telehealth in Physiotherapy and this was the first therapeutic approach for this case. The treatment lasted 90 days, with two intensive protocols of 15 days (with daily sessions), and weekly maintenance sessions for two months, and this maintenance period was the interval between each intensive protocol.
The therapeutic approach was based on the application of anodic tDCS just above the injured area, with reference electrode in the contralateral supraorbital region, for 20 minutes, with intensity of 2mA. During and after the application of tDCS, exercises were performed for visual stimulation of the peripheral visual field, training of saccadic eye movements, eye pursuit, fixation of the gaze, in addition to activities for visual attention, problem solving and hand eye coordination, characterizing activities for restitution and visual field compensation. tDCS was applied by a physiotherapist specialized in the area, "in loco"; VS was performed via telehealth, guided by a physiotherapist specialized in the area. VS training was based on principles of peripheral visual field stimuli that seek to "fill" images. In addition, we use pre-edited and individualized applications and sequences of stimuli for the perception of luminosity, movement, direction, edges, angles, location, contrast, shapes and figures. For oculomotor training, activities were performed that stimulated eye movements, with emphasis on saccades and pursuit and for the insufficiency of convergence evidenced during the visits, activities were carried out with the aid of fusion cards. All sessions were initiated with activities for visual attention, eye fixation, problem solving and hand eye coordination. It is noteworthy that, during the intervention, the patient did not present adverse effects.

RESULTS

After the intervention protocol, we observed restitution of the affected visual field, proven by campimetry examination (Figure 1), as well as improvement of the result in the execution of the activities presented as the main complaint, in addition to the positive evolution in the context of insufficiency of convergence with reduction of symptoms such as visual fatigue.

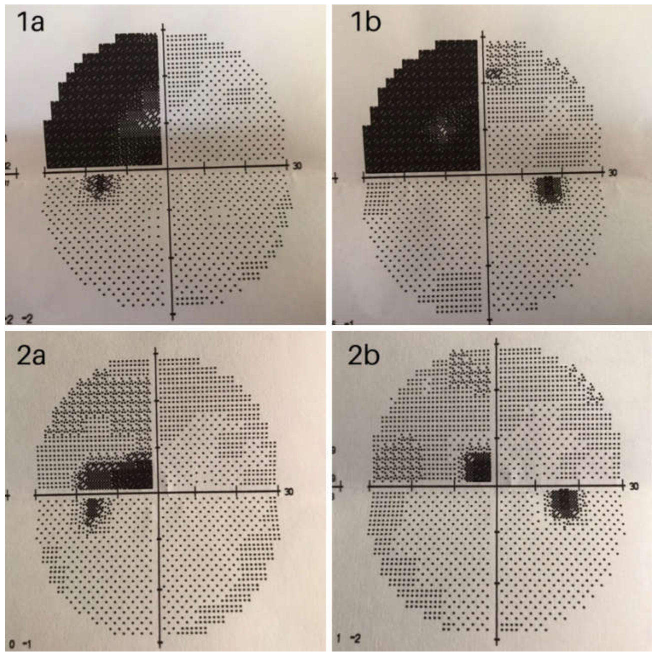

Figure 1. Comparison of computerized campimetry tests in the pre- and post-intervention periods. 1a: Left eye in the pre-intervention period; 1b: Right eye in the pre-intervention period; 2a: Left eye in the post-intervention period; 2b: Right eye in the post-intervention period

DISCUSSION

The efficacy of an intervention protocol with tDCS and VS for the treatment of visual field loss after stroke, as observed in this study, contradicts part of the literature. Some studies show that treatments aimed at the restitution of the visual field after stroke present controversial methodologies and results, which is an area that needs clarification. In 2011, Pollock *et al*. conducted a systematic review composed of 12 randomized clinical trials and 1 randomized controlled crossover trial, which included 344 subjects with visual field loss after stroke. In the included studies, interventions were performed aimed at the restitution of the defective visual field or to improve the patient's ability to deal with visual field loss through compensation and substitution strategies. According to this study (Pollock *et al*. 2011), there is limited evidence that supports the use of compensatory scanning training for patients with visual field defects (and possibly coexisting visual neglect) to improve scan and reading results. There is insufficient evidence to reach a conclusion on the impact of compensatory scanning training on functional activities of daily living. There is insufficient evidence to reach generalized conclusions about the benefits of visual restitution training (VRT) or prisms (substitute intervention) for patients with visual field defects after stroke. Still, Pollock *et al*. (2020) conducted a systematic review that included 20 studies with 547 post-stroke patients. The objective was to verify the effect of the treatments proposed for visual field defects. Among the approaches were proposals for restitutive, substitute and compensatory treatment, based on the performance of eye movement exercises and the use of prisms. Due to the lack of consistency of the data obtained in the review, it was concluded that: there is not enough evidence to prove the effectiveness of the restitution interventions; there is evidence of low or very low quality that compensation training can help improve quality of life, but it may have no effect on other variables and ultimately there is low or very low quality evidence that prisms can have an effect on search ability (look) for objects, however, they can cause a variety of adverse events (such as headache) and may have no effect on other variables. Our results, in this case, do not corroborate the reviews by Pollock et al., mainly due to the restitution observed in different regions of the visual field, confirmed by campimetry examination. One possibility to justify the perceived difference is that, in our treatment, we performed previous training for visual fixation and visual attention, facts that facilitate the execution and improve the performance of peripheral visual training, allowing stimuli to actually reach the periphery of the retina to later follow its path to the corresponding visual cortex. As a counterpoint, obviously we should note that this is a modest result, since it has been observed only in one patient so far. Bouwmeester L. et al. (2007) conducted a systematic review to evaluate the effects of visual training for patients with visual field defects. The objectives were to review whether systematic visual training can lead to a restitution of the visual field to increase the size of the visual field or an improvement in scanning strategies (compensation), in addition to observing whether there is the transfer of improvements related to training in activities of daily living, such as reading. Of the studies included in this review (Bouwmeester L. et al., 2007), five reported a significant effect of vision restitution training (VRT), while two studies reported no effect, using scanning laser ophthalmoscopy or Goldmann perimetry as a measure of outcome. In studies on compensatory therapy, improvement of up to 30° was found in the visual field, in addition to a significant increase in reading speed or reduction of reading errors. However, it is unclear to what extent patients benefit from restitution therapy compared to a compensation strategy to improve reading speed or avoid obstacles in the environment more effectively. Finally, it seems that compensatory training can provide a better rehabilitation compared to restitutive techniques. In our case, we associate compensatory training with restitutive training and, as a complement, we train with specific activities the reaction time to external stimuli, a fundamental fact for activities such as driving a car. The association of the techniques in our case report may have two-way. One of them is the masking of the effect of each of the activities, a fact that may confuse the choice of future therapies. The other way is, through the interpretation that in the "normal" motor behavior of the human being, at all times there is the integration of systems and functions related both to peripheral perception strategies and to the visual search to perceived stimuli.

Thus, it is possible to believe that the good result found is also related to the execution of simulated activities closer to reality than would be the integration of systems for their execution. According to the systematic review conducted by Howard C, Rowe FJ. (2018), which investigated the efficacy of treatment interventions for visual field loss, there is some limited evidence to support the use of compensatory scanning therapy to improve search and read results in people after stroke. In addition, there is insufficient evidence to reach conclusions about the benefits of visual restitution training (VRT) or prisms for this patient court. And yet, there is a substantial amount of evidence that patients can receive support to compensate for and adapt to visual field loss after a stroke, using a variety of strategies and methods. However, this systematic review highlights the fact that many unanswered questions in the area of treatment to visual field loss remain. Thus, again the results obtained by the review contradict the results of the present case, because as previously mentioned, there were significant improvements in relation to the process of reading and performing ADLs, such as driving a car. In our case, when visual stimulation activities are performed, we used concepts highlighted by RAZ and LEVIN (2017), in which stimuli are offered in the transition zone between the preserved visual field and the compromised visual field, with the patient oriented to focus on a central fixation, point and respond whenever he saw light or shape/object projected in any other parts of the screen. Training using this approach includes intensive practice to react to stimuli projected within the blind visual field. Stimuli are projected near or far from the fixation point and the patient is instructed to identify the stimulus, its position or its direction. Restorative methods assume that intense training in the transition zone is capable of reactivating residual neurons located within or at the boundaries of the damaged area. Thus, repeated practice strengthens synaptic connections with residual tissue and improves visual function in defective visual fields. After the intervention proposed in this case, it was possible to observe the evolution of residual vision, both in clinical trials and in campimetry. We believe that tDCS facilitated the activation of the remaining neurons and the association with VS enhanced its function. Finally, it is clear that there is a need to evolve the proposed treatment strategies, as well as the verification of results in large populations in controlled clinical trials.

CONCLUSION

In this case report, it was possible to observe that an intervention protocol with tDCS, associated with VS, could promote positive effects in relation to the restitution of the visual field in an adult patient after stroke, providing improvement of vision, quality of life and execution of activities of daily living. In addition to providing the individual with a return to global functionality, we believe that he has positively influenced the prevention of deficits associated with aging that will accompany him/her, since one of the functions of the peripheral visual field is related to the maintenance of posture and balance. Although the result is satisfactory, it is necessary to carry out studies of greater proportion in case of the development of intervention protocols with greater resolution and scientific relevance.

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