EFFECTS OF TRANSCRANIAL STIMULATION AND PROPRIOCEPTION ON THE STATIC BALANCE OF A CHILD WITH MODERATE VISUAL IMPAIRMENT: A CASE REPORT

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ABSTRACT

Vision and proprioception are fundamental for sensorimotor integration. **Objectives:** this study aims to identify the effects of a single session of transcranial direct current stimulation associated with proprioceptive exercises on the static balance of a 10-year-old child with moderate visual impairment. **Methods:** the work is a case report involving a 10-year-old child with moderate visual impairment. The patient was referred by professionals from the CEMAD of the municipality of Anápolis, GO. The therapeutic intervention consisted of using tDCS during a single session, associated with a series of static proprioceptive exercises. **Results:** The results obtained by comparing the postural balance parameters in the tests with eyes open (OASE) and eyes closed (OFSE) before and after the intervention show that postural stability was significantly affected in the tests with eyes open. The increase in the longitudinal displacement of the center of pressure (COP) suggests a decrease in stability, possibly due to a greater dependence on vision. The reduction in the number of peaks and in the amplitude of movements may indicate an attempt by the system to stabilize itself with less variability. **Conclusion:** These findings may guide future investigations into the mechanisms of postural balance adaptation under different sensory conditions.

Keywords: Child; Visual Impairment; Transcranial Stimulation; Balance; Proprioception.
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INTRODUCTION

Vision plays a crucial role in sensorimotor integration, as eye movements direct the area of greatest visual acuity to objects of interest (OGUSUKO et al., 2008). Visual impairment (VI), which can be caused by diseases, trauma, or congenital conditions, limits essential visual functions such as visual acuity and contrast sensitivity (STEINMETZ et al., 2021). Adaptation to this deficiency depends on stimulation and training (LAZZOUNI; LAPORE, 2014).

Therapeutic methods such as Transcranial Direct Current Stimulation (tDCS) have been used to improve visual function and sensorimotor integration. tDCS, a non-invasive neuromodulation technique, uses a weak electrical current to modify brain excitability and is applied to the Primary Somatosensory Cortex (S1) in individuals with and without visual impairment (DIMOVA, 2010).

Besides vision, proprioception --- which involves receptors in muscles, tendons, and joints that send information about movement and body position to the central nervous system - is essential for postural control (BALDAÇO, 2010). Maintaining balance requires the integration of visual, vestibular, and proprioceptive information to constantly adjust muscle activity and joint positioning. For children and adolescents with visual impairment, the combination of proprioceptive training with other therapies has shown benefits in improving balance and quality of life, as evidenced by studies using mobile platforms (CORNA et al., 2003; SCHMID et al., 2007).

METHODOLOGY

The present work is a case study conducted with the participant N.B.S.R. (ICD 54.1), male, aged 10 years, weighing 21kg; 1.30 m tall. The study followed the ethical guidelines for research with human beings from the National Health Council and was approved by the Ethics Committee of UniEVANGÉLICA, in Anápolis, GO. Only those who consented to the data collection protocols by signing the Free and Informed Assent Term (TALE) and the Free and Informed Consent Term (TCLE) by their parents and/or guardians participated in the research.

The case report was composed of one participant with moderate visual impairment (ICD 54.1), who was referred by professionals from the Municipal Center for Diversity Care (CEMAD) in the city of Anápolis, GO. Subsequently, the individual underwent a screening, where information regarding personal details and anthropometric measurements was collected.

After screening, the participant underwent evaluations at UniEVANGÉLICA in the Human Movement Analysis Laboratory -- LAAMH, conducted by the same physiotherapist and assistants to avoid the risk of bias, with experience in data collection.

Static balance was assessed using a force platform (Kistler model 9286BA) that recorded center of pressure (COP) oscillations at 50 Hz, captured by piezoelectric sensors. The data were analyzed by the SWAY software (BTS Engineering), synchronized with the SMART-D system. Participants remained standing for 30 seconds, barefoot and shod, with arms at their sides, measuring the displacement of the COP on the X and Y axes, under eyes open and closed conditions.

The therapeutic intervention consisted of the application of transcranial direct current stimulation (tDCS) during a single session, associated with static proprioceptive exercises. tDCS was performed with a Transcranial Stimulation device (Transcranial Technologies, USA) using two surface sponge electrodes (non-metallic) of 5x7 cm², moistened in saline solution between 15-140 mm (DUNDAS, J. E.; THICKBROOM, G. W.; MASTAGLIA, F. L. 2007)[8], positioned with the anodal electrode on the cerebellum and the cathode on the supraorbital region. The stimulation was applied simultaneously with the protocol of dynamic and static proprioceptive exercises.

Static Proprioceptive Exercises

The static proprioceptive exercise program included five steps: 1) on the toes with feet apart on a trampoline; 2) on the toes with feet together; 3) supported only on the right foot without support; 4) supported only on the left foot without support; and 5) standing with the right heel touching the toes of the left foot (or vice versa). The exercises were performed on an unstable surface (proprioception board) in three sets of each anteroposterior and laterolateral axis. Each exercise was repeated in 6 sets of 30 seconds, with one minute of rest between sets.

The statistical analysis performed compared the static balance parameters before and after the intervention, calculating means and standard deviations for Longitudinal COP Displacement (mm), Peak Amplitude (s), Peak Time (s), Maximum Frequency of the Px Spectrum (Hz), and Maximum Frequency of the Py Spectrum (Hz).

RESULTS AND DISCUSSION

The results presented in Table 1 show significant changes in postural stability, especially in the re-evaluation of the tests with eyes open (OASE) and closed (OFSE). These findings confirm the literature on the influence of vision on postural control.

Previous studies, such as those by Shumway-Cook and Woollacott (2017), highlight vision as crucial for maintaining balance. The increased COP displacement observed in the re-evaluation of the tests with eyes open is consistent with Horak and Macpherson (1996), who point out that the absence of visual information leads to a greater dependence on somatosensory and vestibular systems, resulting in greater instability.

The change in the maximum frequencies of the Px and Py spectrum is also supported by McCollum and Leen (1989), who suggest that the oscillation frequency increases as a compensatory mechanism in the face of perceived instability. This is aligned with the increase in the maximum spectrum frequencies in tests with eyes open.

Furthermore, the greater instability with eyes closed is corroborated by Peterka (2002), who observes that the lack of visual information increases postural sway and the difficulty in maintaining balance. The increase in longitudinal COP displacement and the decrease in the maximum frequency of the Px spectrum with eyes closed, observed in Table 1, are consistent with these findings, indicating a reduced capacity for lateral adjustment and a greater difficulty in maintaining stability in the absence of visual reference.

These results reinforce the importance of vision in the control of postural balance and show that, without visual information, there is greater instability. The observed adaptations, such as the increase in oscillation frequency and the greater amplitude of movements, suggest a compensatory effort by the system to maintain balance.

Table 1: Comparison of Postural Balance Parameters in Tests with Eyes Open (OASE) and Eyes Closed (OFSE) before and after the intervention.

Parâmetros	**OASE**	**OASE Pós-intervenção**	**OFSE**	**OFSE Pós-intervenção**
Deslocamento COP Longitudinal (mm)	3.166.042	5.267.537	1.949.374	9.639.497
Amplitude do Pico (s)	1.093.514	0.686269	0.692985	0.880262
Tempo de Pico (s)	1.000.000	0.850000	0.964516	1.042.857
Frequência Máxima do Espectro Px (Hz)	0.019531	0.312500	0.058594	0.039062
Frequência Máxima do Espectro Py (Hz)	0.039062	0.312500	0.078125	0.039062

Legenda: mm – milímetros; s – segundos; Px – Plano x; Py – Plano y; Hz – hertz.

CONCLUSION

The comparison between the postural balance tests with eyes open (OASE) and eyes closed (OFSE) revealed significant differences in the participant's postural stability. The increase in Center of Pressure (COP) displacement after the intervention suggests a decrease in stability, with vision playing a crucial role in motor control. The presence of visual references in OASE led to more effective compensatory strategies, while the absence of vision in OFSE resulted in greater instability and difficulty in postural correction. These results highlight the importance of visual information in balance and indicate the need for further research on the adaptive mechanisms of postural balance under different sensory conditions.

REFERENCES

ALRASHEED S. Systematic review and meta-analysis of childhood visual impairment in the Eastern Mediterranean Region. **East Mediterr Health J. 2023** Jun 27;29(6):482-490. doi: 10.26719/emhj.23.020. PMID: 37551760.

BALDAÇO, F.O. Análise do treinamento proprioceptivo no equilíbrio de atletas de futsal feminino. **Fisioterapia Movimenta; v.23, n.2, p.183- 92, 2010.**

CORAZZA, et al. Benefícios do treinamento funcional para o equilíbrio e propriocepção de deficientes visuais. **Rev. Bras Med Esporte,** vol.22, n°6, Nov/dez, 2016.

DALL'AGNOL, P. A. Efeitos da Estimulação Transcraniana por Corrente Contínua em Tarefas de Percepção Tátil Manual - Desempenho Tátil entre indivíduos com visão preservada e deficientes visuais. **Universidade Presbiteriana Mackenzie.** São Paulo, 2011.

DAMIÃO, Carolina Ferreira. Efeitos da estimulação transcraniana por corrente contínua em crianças com paralisia cerebral: revisão sistemática. 2021. **Trabalho de conclusão de curso de graduação (Fisioterapia) - Instituto de Saúde e Sociedade**. Universidade Federal de São Paulo, Santos, 2021.

DIMOVA. V., UTZ K. S., Oppenländer K, Kerkhoff G. Electrified minds: Transcranial direct current stimulation (tDCS) and Galvanic Vestibular Stimulation (GVS) as methods of non-invasive brain stimulation in neuropsychology—A review of current data and future implications. **Clinical Neuropsychology Unit, Saarland University, Saarbruecken, Germany Neurological Clinic Bad Aibling, Germany, 2010.**

HORAK, Fay B.; MACPHERSON, Janet M. Postural orientation and equilibrium. In: HANDBOOK of Physiology. American Physiological Society, 1996. p. 255-292.

LAZZOUNI, L.; LAPORE, F. Compensatory plasticity: time matters. **Frontiers in human neuroscience, v. 8, p. 340, 2014.**

MCCOLLUM, Glen; LEEN, Todd K. Form and exploration of mechanical stability limits in erect stance. **Journal of Motor Behavior**, v. 21, n. 3, p. 225-244, 1989.

PETERKA, Robert J. Sensorimotor integration in human postural control. **Journal of Neurophysiology,** v. 88, n. 3, p. 1097-1118, 2002.

RANGEL, et al. Deficiência visual e plasticidade no cérebro humano. **Revista psicologia: Teoria e prática**, v.12, n.1, p.197-207, 2010.

RIBEIRO, et al. Características da marcha em sujeitos com deficiência visual. **Rev. Ter Man**, 2010; n°8, pág. 27-32.

SCHMID, M. et al. Equilibrium during static and dynamic tasks in blind subjects: no evidence of cross-modal plasticity. **Brain,** v. 130, n. 8, p. 2097-2107, 2007.

SHUMWAY-COOK, Anne; WOOLLACOTT, Marjorie H. Motor Control: Translating Research into Clinical Practice. **Lippincott Williams & Wilkins**, 2017.