

IMPACTS OF A SINGLE SESSION OF TRANSCRANIAL DIRECT CURRENT STIMULATION COMBINED WITH PROPRIOCEPTIVE EXERCISES ON GAIT IN CHILDREN WITH VISUAL IMPAIRMENT: A CASE STUDY

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ABSTRACT

Loss of vision promotes various alterations in the sensorimotor system, requiring the activation of neuroplasticity in the central nervous system. This excitation, combined with transcranial stimulation, aims to induce more effective modulations and adaptations in gait. **Objectives:** This study aims to identify the effects of a single session of transcranial direct current stimulation combined with proprioceptive exercises on the spatiotemporal parameters of gait in children and pre-adolescents with visual impairment. **Methods:** This is a case study involving a 10-year-old child with moderate visual impairment. The sample was referred by the Municipal Center for Diversity Care (CEMAD) in Anápolis. Initially, the sample underwent a screening process using a child identification form to analyze all inclusion and exclusion criteria. Subsequently, the participant underwent evaluations at UniEVANGÉLICA in the Human Movement Analysis Laboratory (LAAMH). **Results:** The results obtained from comparing spatiotemporal parameters before and after the intervention showed no statistical differences only in speed and absolute step length. **Conclusion:** Thus, the visually impaired child evaluated generally exhibited significant differences in nearly all assessed parameters.

Keywords: Transcranial stimulation, Proprioception, Gait, Children, Visual impairment.

INTRODUCTION

Visual impairment, defined as a total or partial loss of vision, leads to gait impairments. This is because vision is essential for providing sensory data that enable the planning of steps (JUNIOR et al., 2013). Consequently, it affects gait speed, step length, foot placement on the ground, and deviation from a straight path (HALLEMANS, 2010). Nakamura suggests that such adaptations reflect a strategy to maintain a more stable and functional posture.

Transcranial Direct Current Stimulation (tDCS) is a simple, safe, and non-invasive neuromodulation technique (BOGGIO, 2007). tDCS has been used in visually impaired individuals (VI) due to its ability to induce motor cortex excitability, promoting modulatory effects (MONTENEGRO, 2013). These responses serve as

alternatives to improve the quality of life of VI individuals by stimulating their gait. Another advantage of tDCS is its compatibility with other therapeutic resources for enhanced rehabilitation.

Visual stimuli provide conditions for individuals to move while maintaining spatial and postural awareness (CORAZZA, 2016). When performing a dynamic motor action, the precision with which the movement is executed is crucial for producing controlled and planned actions (TEIXEIRA, 2006). Thus, incorporating proprioceptive exercises into spatiotemporal parameter training proves to be an important alternative for stimulating spatial perception in children with visual impairment.

METHODOLOGY

This study is a case study conducted with participant N.B.S.R. (ICD 54.1), male, 10 years old, weighing 21 kg, and measuring 1.30 m in height.

The study followed the guidelines and norms formulated by the National Health Council, Ministry of Health, and was approved by the Ethics Committee of the Centro Universitário de Anápolis - UniEVANGÉLICA, Anápolis, GO. The child consented to the protocols through the Free and Informed Assent Term (TALE), and their guardians consented through the Free and Informed Consent Term (TCLE). Their rights were guaranteed in accordance with Resolution No. 466/2012.

The child was referred by the Municipal Center for Diversity Care (CEMAD) in Anápolis, GO. Subsequently, personal data and anthropometric measurements were collected. After analyzing the inclusion and exclusion criteria, the participant underwent evaluations at UniEVANGÉLICA in the Human Movement Analysis Laboratory (LAAMH).

The Walk Test is an examination in which the patient must walk seven meters at a self-selected speed, combined with the G-Sensor® (BTS Bioengineering S.p.A., Italy), which provides quantitative analysis of gait parameters (Figure 1). The G-Sensor is a portable inertial sensor; for the test, it was attached to the S1 region of the patient (Figure 2).

Figura 1 Sensor inercial G-sensor.



Fonte: Manual da BTS Bioengenharia.

Figura 2 Realização do *Walk test* juntamente com o G-sensor.



Fonte: Autoras.

The intervention used transcranial direct current stimulation (tDCS) in a single session combined with a series of dynamic proprioceptive exercises. The tDCS was applied using the Transcranial Stimulation device (Transcranial Technologies, USA), through two sponge-surface electrodes (DUNDAS, J. E; THICKBROOM, G. W.; MASTAGLIA, F. L. 2007). The anodal electrode was positioned on the cerebellum and the cathodal electrode on the supraorbital region.

The proprioceptive exercise program was conducted in five stages: 1) walking sometimes slowly and sometimes faster on a trampoline; 2) walking with one foot behind the other; 3) walking forward on a balance beam; 4) going up and down a flight of stairs; and 5) sitting on a Swiss ball, performing lateral-lateral, anteroposterior, circumduction, and "bouncing" exercises. Activities 1 to 4 were performed in 3 sets of 1 minute each and activity 5 in sets of thirty seconds each.

RESULTS

Table 1 presents a comparison of gait parameters before and after the intervention. The support phases were evaluated: the left leg increased (from 58.6% to 61.8%), and the right leg decreased (from 61.0% to 56.8%). Suggesting an improvement in observed symmetry. The swing phase of the left side decreased (from 41.4% to 38.2%), and the right side increased (from 39.0% to 43.2%).

Tabela 1: Comparação dos Parâmetros de Marcha Antes e Depois da Intervenção.

Parâmetros	Antes	Depois	Média	Desvio Padrão (\pm)
Duração da Análise (s)	21.9	19.2	20.55	1.91
Cadência (passos/min)	116.6	125.9	121.25	6.58

Comprimento do Passo (% do comprimento total)				
Esquerdo	-	48.6	50.0	1.98
Direito	-	51.4	50.0	1.98
Passos Elaborados				
Esquerdo	11	9	10.0	1.41
Direito	9	10	9.5	0.71
Fase de Apoio (Stance Phase)				
Esquerdo	58.6%	61.8%	60.2%	2.26%
Direito	61.0%	56.8%	58.9%	2.97%
Fase de Balanço (Swing Phase)				
Esquerdo	41.4%	38.2%	39.8%	2.26%
Direito	39.0%	43.2%	41.1%	2.97%
Primeira Fase de Apoio Duplo (First Double Support Phase)				
Esquerdo	11.3%	11.3%	11.3%	0.00%
Direito	9.2%	11.3%	10.25%	1.48%
Fase de Apoio Único (Single Support Phase)				
Esquerdo	38.0%	42.6%	40.3%	3.25%
Direito	41.4%	37.9%	39.65%	2.48%

The first double support phase showed an increase on the right side (from 9.2% to 11.3%). In the single support phase, the left side increased (from 38.0% to 42.6%), and the right side decreased (from 41.4% to 37.9%), suggesting a redistribution of support time.

Tabela 2: Comparação dos Parâmetros de Marcha Antes e Depois da Intervenção.

Parâmetro		Antes	Depois	Valores Normais
Duração da Análise		21.9 s	19.2 s	-
Cadência		116.6 passos/min	125.9 passos/min	117.0-139.8 passos/min
Passos Elaborados (Esquerdo)	Elaborados	11 passos	9 passos	-
Passos Elaborados (Direito)		9 passos	10 passos	-

Table 2 presents a comparison of gait parameters before and after the intervention. The analysis duration was reduced from 21.9 seconds to 19.2. The cadence, which increased from 116.6 steps/min to 125.9. The percentage distribution of step length after the intervention was 48.6% for the left foot and 51.4% for the right foot, while the number of steps taken decreased for the left foot and increased for the right foot.

The results indicate significant improvements in gait symmetry and stability. Perry and Burnfield (2010) emphasize that gait interventions can increase symmetry

and redistribute load between limbs, which was observed with the increase in the support phase of the left leg and the decrease in the right leg. Olney and Richards (1996) corroborate the relevance of the swing phase, where the observed changes suggest a rebalancing of gait. Patla (1997) discussed that stabilization in the double support phase may reflect greater security in gait, something also verified in this study. Finally, Winter (1995) pointed out that the redistribution of support time, as observed in the single support phase, is essential to improve balance and stability.

CONCLUSION

Based on the presented data, an improvement in gait cadence is observed after the intervention, indicative of a more efficient walking rhythm. However, the speed and absolute step length remained unchanged at 0.00 m/s and 0.00 m, respectively, suggesting a possible problem in data collection or a limitation in the individual's mobility. The redistribution of step length between the right and left feet indicates a slight asymmetry. These results point to the need for a reassessment of data collection methods and the continuity of interventions to improve gait parameters.

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