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RESEARCH ARTICLE OPEN ACCESS

EFFECTS OF A JOBA HORSE RIDING SIMULATOR ON POSTURAL BALANCE IN CHILDREN WITH SPASTIC CEREBRAL PALSY

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ABSTRACT

Objective: The present study sought to identify the effects of the JOBA® horse riding simulator on the postural balance of children with spastic CP. **Methods:** The study included 17 children aged between 3 and 12 years. The Loran Engineering® baropodometric platform was used to assess the sitting position with eyes open and eyes closed. The GMFCS system was used for the classification of functionality. **Results:** After statistical analysis, the effectiveness of the use of the horse riding simulator for all variables analyzed was verified, demonstrating an improvement in the results in both the stable and unstable condition. **Conclusion:** The horse riding simulator proved to be efficient for improving the balance and posture of the patients treated.

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INTRODUCTION

Cerebral Palsy (CP) is caused by abnormal brain development that affects the child's ability to control their movements, with changes in posture and tone, causing impacts in the lives of the children and their families, impairing functionality and general mobility, motor disorders may be accompanied by disorders of cognition, perception, communication, behavior, and may also present with epilepsy, these limitations are widely discussed, with ways to minimize them being among the major challenges for families, researchers and child rehabilitation professionals (Vitor, 2015; Ande-Brasil). For children with CP, maintaining the balance is a daily challenge. The motor responses received from the vestibular, proprioceptive and visual systems are ways for the individual to perform postural control by aligning the balance. Balance is one of the fundamental skills for carrying out activities of daily living, for both children with CP and children with typical development (Ande-Brasil). There has been much research regarding therapeutic alternatives for patients with cerebral palsy, aiming for postural control against gravity and to provide better balance, reach, mobility and consequently gains in functional activities. Hippotherapy has been indicated as an excellent kinesiotherapeutic resource with multidisciplinary potential, directed toward improving the motor and biopsychosocial development of adults and children with special needs[3].Studies on hippotherapy have demonstrated good evolution of patients with CP. Currently, the use of this resource has been seen as a short-term option and can be used as stimulation for different aspects of development, as the walking of the horse promotes multiple effects on the practitioner's body, causing postural adjustments and stimulating neuronal plasticity in the brain, influencing the patient's functionality and quality of life (Borges, 2011). Horse riding simulatortherapy is among the therapeutic resources similar to hippotherapy and has been an option for treatment in indoor environments. Various hippotherapy centers provide treatment for children with cerebral palsy; however, several factors make this practice difficult and sometimes even impossible, such as climatic conditions, the need for handlers and access to riding centers (Temcharoensuk *et al.,* 2015). The therapeutic effects of the two modalities are the same and include improving postural stability, increasing sensory inputs, decreasing or increasing muscle tone, improving range of motion, facilitating muscle synergy and greater functionality in activities of daily living (Park, 2014). In addition, the

literature states that the horse's gait and the rhythmic and three-dimensional movement of riding improve flexibility, posture, balance and mobility, which facilitate the stabilization of the dynamic posture and activities of daily living (Herrero, 2010). Children with CP treated through therapy with the simulator showed an evident improvement in the assessment of maximum displacements in the anteroposterior (AP) and mediolateral (ML) directions, when compared to a control group, treated through conventional physiotherapy based on the Bobath Neuroevolutionary Concept[4]. Playful therapy, which uses the horse riding simulator, provides opportunities for new treatments for children with CP, which makes it of great social interest, not only due to the benefits that can be obtained with the therapy, but also due to the recreational character of the activity and the possibility of combining simulator therapy with other types of therapy (Brogren, 1998). The aim of the present study was to evaluate the effects of a therapeutic riding simulator on the postural balance of children with spastic type CP, by means of measures of the anteroposterior (AP) and mediolateral (ML) displacements, in the sitting position, with eyes open (EO) and closed (EC).

METHODS

This quasi-experimental, descriptive and comparative study was carried out at the community service center of the Uni CEUB Physiotherapy School-Clinic and the Special Education Center 2, located in Brasília, Brazil. The study included children aged between 3 and 12 years of age treated at the participating institutions, with a clinical diagnosis of spastic type CP and with minimal trunk stability conditions. The study participants needed to have minimum conditions for understanding the orders given and be classified by GMFCS at levels I, II, III or IV.

Figure 1. Horse riding simulator

Figure 2. Child sitting during therapy

Children that were unable to maintain their seated posture without support for at least 90 seconds were excluded, as were those that underwent other types of motor therapy during the study and those that presented comorbidities such as visual or hearing problems, seizures, arrhythmias or other medical complications that presented risks for participation. All those responsible for the participants signed a consent form and the study was approved by the Research Ethics Committee, under authorization number 2.021.774.

Procedures: The evaluations were performed at the beginning and end of the treatment using the Loran Engineering Baropodometric Platform® with the Biomech 2014 software. The baropodometric measurements were performed by measuring anteroposterior (AP) and mediolateral (ML) displacements before and after the interventions under four different sensory conditions, with the individual sitting on the Baropodometer, a) without foot support, with eyes open (EO); b) without foot support with eyes closed (EC); c) with foot support, with eyes open (EO); and d) with foot support, with eyes closed (EC). The analysis was carried out initially with all research participants, with them subsequently separated into two groups, G1 (children with GMFCS I and II) and G2 (children with GMFCS III and IV). The treatment consisted of 12 sessions on the JOBA® horse riding simulator, Model EU6310 (Figure 1), level 1 being 3 times a week with 30 minutes duration each. For the present study, a stirrup was adapted to better accommodate the patient's feet, providing stability (Figure 2).

Statistical analysis: The variables were checked for normal distribution using the Shapiro-Wilk test. The numerical variables were expressed as mean ±standard deviation and the categorical variables as absolute and relative frequency. To check the effects of the intervention on the dependent variables, paired *t*-tests were performed for the intragroup analyses (pre and post) and independent *t*-test for analysis between the groups. Cohen's *d* was also calculated to measure the magnitude of the treatment effect. The level of significance adopted was $p < .05$ and all analyses were conducted using the SPSS software, version 23.

RESULTS

A total of 25 children were selected according to the established inclusion criteria and, after an initial evaluation, 17 remained in the study with a mean age of 7.06 (±2.904) years, of both sexes, 8 boys and 9 girls, presenting a mean BMI of 14.1 kg. Twelve were topographically classified with unilateral lesions (hemiparetic) and five with bilateral lesions with crural predominance (diparetic), while in terms of tone, eleven were dyskinetic and six spastic. Four used a walker, eight could walk independently (among these, two used an ankle-foot orthosis) and five were wheelchair users.

After the analysis of the statistical data, using the paired *t*-test, it was observed that the measures for the COP X (Center of Pressure) condition, both unstable (without foot support) and stable (with foot support), and for COP Y(Center of Pressure) for the unstable situation, eyes open (EO), reached a satisfactory statistical significance index for G1.

When G2 was assessed, the statistically significant response was observed only for COP Y(Center of Pressure), both in the unstable and stable situation with EO (Table 1).

Table 1. Means of the difference between the beginning and the end of the treatment in AP and ML displacements with open eyes (EO) and eyes closed (EC) unstable (U) and stable (S) of groups G1 and G2. Data expressed as mean ±standard deviation

	Group 1 (*n*=8).*		Group 2 (*n*=9).*		Independent *t*-test
	Paired *t*-test	*p* [a]	Paired *t*-test	*p* [a]	*p* [b]
AP_U_EO	0.86 ± 2.08	.280	0.37 ± 1.74	.395	.289
AP_U_EC	1.22 ± 1.41	.044*	0.25 ± 2.19	.640	.084
AP_S_EO	0.96 ± 0.89	.019*	0.27 ± 1.37	.420	.049*
AP_S_EC	0.12 ± 1.35	.980	0.23 ± 1.59	.552	.604
ML_U_EO	0.66 ± 0.69	.031*	0.63 ± 1.06	.020*	.924
ML_U_EC	0.36 ± 0.75	.218	0.13 ± 0.80	.500	.288
ML_S_EO	0.28 ± 0.46	.121	0.41 ± 0.70	.029*	.513
ML_S_EC	0.36 ± 0.69	.246	0.03 ± 0.82	.862	.126

p[a]: *p*-value of the intra group comparison; *p*[b]: *p*-value of interaction between groups

DISCUSSION

When evaluating the AP and ML displacements of the children with spastic CP, in the sitting position, with EO and EC, before and after intervention with the JOBA® horse riding simulator, through the baropodometric analysis, a statistically significant improvement was observed between the initial and final measurements in the maximum displacements in the AP directions for the entire sample studied. Corroborating this finding, Brogren and Hadders-Algra[9] reported that normally the AP displacement is greater than the ML displacement, since it is widely used for manual reach during daily activities. In addition, the rounded shape of the is chial tuberosity induces a movement of the pelvis in the AP direction, allowing greater displacement than in ML direction, in addition to the greater contact area due to the length of the thighs. Children with CP treated with an artificial mechanical saddle achieved a statistically significant improvement in postural stability related to the maximum displacements in the AP and ML directions evaluated through a pressure platform, with the AP displacement of the center of pressure being slightly higher than that of the ML, a result similar to that found in the present study (Kubota, 2006). Some authors have justified the gains in balance and posture of the patients studied through the increase in muscle contraction performed during the treatment.

One study with older adults and children with CP using the horse riding simulator reported that there was an improvement in muscle contraction strength in the older adults and children with CP, highlighting the significant improvement in postural control and balance. The author also reported that there were positive effects related to the control and balance and stated that the riding simulator provided an excellent benefit for children with CP, improving their postural control and global function (Lee, 2014).During hippotherapy and therapy with the horse riding simulator, improvements in facilitating muscle co-contraction and postural balance occur, resulting in improvements in the gross motor function of children with CP. In the present study, when evaluating the displacements, it was observed that there was a significant difference between the initial and final measurements of the stable and unstable AP with eyes open considering the intragroup comparison. Children with spastic CP exhibit more swaying movements with the eyes closed than with them open, indicating that these children have greater difficulties in organizing themselves in times of deprivation of visual information (Donker *et al.,* 2008). When comparing the trajectory of the center of pressure with eyes open and eyes closed of children with CP and children with typical development, measured using a force platform, it was observed that children with CP exhibited more sway (Trindade, 2013; Carlberg, 2005).

The position considered ideal for the baropodometric assessment of children with CP has been discussed a lot. There are those that defend the upright sitting posture, others the posture that leads to a greater anterior inclination of the trunk, while others prefer the reclined posture. The ideal is to find a position that allows the child to control the arms and head in an ideal way for carrying out functional activities, such as eating, getting dressed and communicating (Pavão, 2015).

Therefore, in the present study, children were evaluated in a sitting position, favoring postural control. The same posture was used to assess posturography, which is the technique used to measure body sway, therefore when using baropodometry to assess the postural balance, the sitting posture was found to be effective for the proposal of the present study. The assessment of the postural control of children and young people with CP in the sitting position has been carried out in several studies (Bañas, 2014). However, few studies provide data on baropodometry as an option for the assessment of this population in a sitting position, which can mainly benefit those that cannot maintain the standing position independently. This information on balance is essential to design appropriate interventions to improve activities and participation in functional and daily life activities. Postural stability, or balance, proposes to maintain the center of Mass on the support base, the decrease in balance can limit the child's ability to move voluntarily through the environment and to participate in activities of daily living (Kim, 2020; La Forme Fiss, 2019). The horse riding simulator, used here as a therapeutic resource for the development of better balance, proved to be a motivating strategy, which favored the participants' adherence.Some advantages of this equipment found in the present study have been reported in the literature, such as ease of transport to any place, easy handling and guarantee that the therapy will not be affected by weather conditions[4]. Although widely recommended, there is still little evidence of the effects of the use of hippotherapy or the horse riding simulator on the functionality of children with CP.Studies are unclear and there is a lack of randomized clinical trials in this area of research (Kim, 2020). The effects of the simulator with children with CP on adductor spasticity and hip abduction range of motion have been studied and the results showed a significant reduction in spasticity with improved amplitude in the hip joint (Hemachithra, 2020).

CONCLUSION

The proposed intervention program with the JOBA® horse riding simulator produced beneficial effects on the anteroposterior and mediolateral displacements of children with spastic type CP, in the sitting position, with eyes open and eyes closed, constituting an efficient option for improving the balance of the patients treated.

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