

Effect of hippotherapy on the postural stability of patients with multiple sclerosis: a preliminary study

Efeito da equoterapia na estabilidade postural de portadores de esclerose múltipla: estudo preliminar

Efecto de la hipoterapia en la estabilidad postural de portadores de esclerosis múltiple: estudio preliminar

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ABSTRACT | Objective: This study intended to identify the effects of hippotherapy on the postural control of multiple sclerosis (MS) patients. Methods: Eleven MS patients were separated into two groups: Intervention Group (IG) and Control Group (CG). Hippotherapy consisted of two 50-minute sessions each week for four months. Postural stability was evaluated before and after hippotherapy using a force plate to calculate the center of pressure (COP), when subjects stood still for 30 seconds, with eyes open and closed. Statistical analysis was performed by ANOVA and *post hoc* Tukey tests, $p < 0.05$. Results: Hippotherapy significantly reduced the amplitude of oscillation in the anteroposterior direction in IG while CG remained unaltered. In both groups postural stability was reduced after the suppression of visual information. Conclusions: Hippotherapy induced functional adaptations that resulted in better postural stability of subjects with MS. This study corroborates literature supporting the use of hippotherapy as a possible intervention for balance disorders in patients with MS.

Keywords | postural balance; equine-assisted therapy; multiple sclerosis.

RESUMO | Objetivo: Este estudo se propôs a verificar se a estimulação por meio da equoterapia é capaz de desencadear alterações no controle postural de

portadores de esclerose múltipla (EM). Método: Fizeram parte deste estudo 11 portadores de EM divididos em Grupo Intervenção (GI) e Grupo Controle (GC). O GI foi inserido num programa de hipoterapia durante 4 meses, sendo conduzidas 2 sessões semanais com duração de 50 minutos cada. A estabilidade postural foi avaliada utilizando uma plataforma de força (utilizada para calcular o deslocamento do centro de pressão - COP), durante 30 segundos, em postura ereta quasi-estática, com olhos abertos e fechados, antes e após o treinamento com equoterapia. O tratamento estatístico foi feito através do ANOVA e *Post hoc* de Tukey com $p < 0,05$. Resultados: A amplitude de oscilação anteroposterior reduziu significativamente no GI após a estimulação, enquanto o GC manteve um comportamento inalterado entre as avaliações. Em ambos os grupos, a estabilidade postural foi reduzida com a supressão da informação visual. Conclusões: A adaptação funcional proporcionada pela equoterapia foi capaz de melhorar a estabilidade postural dos portadores de EM. Os resultados corroboram a literatura que suporta o uso da equoterapia como uma intervenção em potencial nas desordens de controle postural em portadores de EM.

Descritores | equilíbrio postural; terapia assistida por cavalos; esclerose múltipla.

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RESUMEN | Objetivo: El objetivo de éste estudio fue identificar los efectos de la hipoterapia sobre el control postural en pacientes con esclerosis múltiple (EM). Método: Hicieron parte de este estudio 11 portadores de EM divididos en Grupo Intervención (GI) y Grupo Control (GC). El GI fue insertado en un programa de hipoterapia durante cuatro meses, siendo realizadas dos sesiones semanales con duración de 50 minutos cada una. La estabilidad postural fue evaluada utilizando una plataforma de fuerza (utilizada para calcular el desplazamiento del centro de presión - COP), durante 30 segundos en postura erecta casi-estática, con ojos abiertos y cerrados, antes y después del entrenamiento con hipoterapia. El tratamiento estadístico fue realizado a través de ANOVA y Post hoc de Tukey

con $p < 0,05$. Resultados: la amplitud de oscilación antero-posterior se redujo significativamente en el GI después de la estimulación, mientras que el GC mantuvo un comportamiento sin cambios entre las evaluaciones. En ambos grupos la estabilidad postural fue reducida con la supresión de la información visual. Conclusiones: la adaptación funcional proporcionada por la hipoterapia fue capaz de mejorar la estabilidad postural de los portadores de EM. Los resultados corroboran la literatura que soporta el uso de la hipoterapia como una potencial intervención en los desordenes del control postural en portadores de EM.

Palabras clave | estabilidad postural; equoterapia; hipoterapia; esclerosis múltiple.

INTRODUCTION

Multiple sclerosis (MS) is a chronic neuropathology characterized by the infiltration of inflammatory cells in the central nervous system (CNS) with presumed autoimmune etiology^{1,2}. Epidemiological studies in North America and Europe point MS as the most common cause of acquired physical incapacity that appears predominantly at the adult age³. In Brazil, studies revealed rates of 15 cases per 100,000 inhabitants in the South and Southeast regions^{4,5}.

Alterations in the mechanisms of postural control and the consequent increase in the number of falls are frequent in MS⁶⁻¹¹. Disturbances in the visual system caused by plaques in the optic nerve¹², the involvement of vestibular ducts associated with vertigo and nystagmus¹³, besides proprioception and spasticity disorders and muscle weakness^{3,8,14,15} are observed in MS. Altogether, these factors can lead to the deterioration of the quality of postural stability.

Studies indicate that interventions such as physical therapy and therapeutic physical exercises can improve many of the deficiencies observed in MS^{3,14,16,17}. However, the effectiveness of such interventions is not always confirmed in relation to functional aspects. Recently, Flachenecker¹⁷ described an overview of rehabilitation strategies designed for autoimmune conditions, identifying as the main components of MS rehabilitation: increased physical capacity, muscle strength, aerobic resistance and functional skills. Once MS involves a wide range of symptoms, the rehabilitation of these patients requires a multidisciplinary approach¹⁷, and more satisfactory results are observed with techniques that make use of sensory strategies¹⁶.

In the past decades, the effectiveness of hippotherapy¹⁸ as a therapeutic method has been described in a series of neurologic conditions that compromise postural control

and mobility¹⁹⁻²². This method requires postural reactions combined with the dissociation of the pelvic and scapular waist, and constant tonic adjustments, besides varying the visual information in quantity and magnitude, and also increasing the demand for sensory information sent to the vestibular system^{19,20}.

Up to the present moment, two articles investigating the effect of the hippotherapy intervention on the balance of patients with MS have been found^{20,23}. These studies used the Berg scale to measure functional balance. Studies that assess and identify the behavior of postural oscillations in this population have not been found. Besides, the implications that visual information produces in the postural control of patients with MS have not been clearly defined yet.

With these conjectures, this study aimed to verify if hippotherapy is able to trigger changes in the postural stability of MS patients.

METHODOLOGY

Design

This study presents a non-random convenience sample, characterizing the research as a non randomized clinical trial with temporal series.

Ethical procedures

The evaluation methods and intervention protocols used in this study are in accordance with the guidelines of Resolution nº 196/96, from the National Health

Council on research involving human beings, and they were approved by the Research Ethics Committee of Federal University of Santa Maria, according to Report nº 0169.0.243.000-09.

Study group

The origin group of this study consisted of 43 subjects with MS who were part of the Association of MS patients of Santa Maria (RS), Brazil. Out of these, 29 subjects were excluded for presenting the inability to stand still, without using a support machine, for at least one minute; for not being allowed to practice hippotherapy by the doctor; and for having previously participated in any equestrian activity.

After clarifying the objectives and methodological procedures, 14 subjects signed the informed consent form and agreed to participate in the study. Out of these, 7 complained of body imbalance and were submitted to 30 sessions of hippotherapy in a four-month period (Intervention Group – IG). The subjects who did not complain of body imbalance and were not interested in participating in the intervention sessions (seven) were observed in the Comparison Group (CG). Three subjects from the CG left the study without completing the final tests. Thus, the study group was comprised of 11 subjects: 7 in the IG and 4 in the CG.

It is worth to mention that the stimulation activities proposed for the IG were included in the routine of the subjects in this study as a complementary therapeutic method, since they were already on some type of therapeutic activity. Daily life activities, medication or the insertion of new activities were controlled and remained unaltered during the period of intervention for both groups. The specifications of groups and the individual characterization of subjects can be observed in Table 1.

Procedures

The clinical history and the anthropometric evaluation were investigated for the description of subjects.

Postural stability was assessed by means of a stabilometry, which registered body oscillations in relation to the center of pressure (COP) of subjects in quasi-static erect posture, placed over a OR6-7 AMTI force plate (Advanced Mechanical Technologies, Inc., USA), with sample frequency of 100 Hz. During the evaluations, the subjects remained barefoot, on biped support, with the feet separated to the width of the hip.

Table 1. Characterization of subjects

Gender	Intervention Group (n=7)				
	Age (anos)	BM (kg)	Height (m)	TD (years)	Therapeutic activities
F	51	75.1	1.7	3	Physical Therapy
F	58	57.6	1.43	28	Physical Therapy
M	40	101	1.7	6	—
F	35	49.5	1.65	14	Yoga
F	45	62	1.66	4	Physical Therapy
F	32	67.8	1.69	4	Physical Therapy
F	47	64	1.51	1	Physical Therapy
Control Group (n=4)					
M	43	75	1.81	1	Pilates
M	43	120	1.78	6	Swimming
F	49	62	1.65	18	Weight lifting
F	54	90.4	1.58	6	—

M: male; F: female; BM: body mass; TD: time of diagnosis of multiple sclerosis. Note: According to the neurological diagnosis, the subjects did not have a defined classification as to the type of multiple sclerosis.

A fixed goal was placed at the height of the eyes and taken back 1 m for visual reference. Two sensory conditions were determined: open eyes (OE), available visual information; and closed eyes (CE), suppressed visual information. Each subject underwent 3 assessments of 30 seconds in each condition. After the period destined to hippotherapy, the subjects were reassessed. Data went through a 10 Hz and 4th order low-pass filter and were processed in a Matlab 7.3 environment (Matrix Laboratory, Mathworks, Inc., USA).

The following variables of COP were considered for analysis: 1) amplitude of anterior posterior displacement (AMPap) — distance between the maximum and minimum displacement of the COP in the anterior posterior direction; 2) amplitude of medial lateral displacement (AMPml) — distance between the maximum and minimum displacement of the COP in the medial-lateral direction; 3) mean speed of the anterior posterior displacement (VMap); and 4) mean speed of the medial lateral displacement (VMml).

Hippotherapy

Sessions took place twice a week, during a four-month period, and lasted approximately 50 minutes each. The initial stage of the session, the approximation stage, lasted for 10 minutes and was developed in two steps: the first one on the ground, in which the subject prepared for the activities through global stretching exercises and established the first contact with the horse. Afterwards, there was the connection between the horse and the rider. At this time, the

participants were guided to reorganize the posture on the horse and adjust the riding accessories according to the objectives of the session. At the main stage, the time of riding was fixed in 30 consecutive minutes with the horse walking. In this stage, exercises to adapt to the riding posture were used, as well as stretching, horseback riding techniques and pre-sports exercises, such as changing directions to stimulate the dissociation of pelvic and scapular waists; ground variations, cadence (sand, asphalt and grass) and terrain (plane, uneven and inclined), with the objective to intensify movements of pelvic anteversion and retroversion. Movements of ankle plantarflexion and dorsiflexion, hip flexion and elevation of the stirrup were used to increase the action of the lower limbs in order to maintain the posture on the horse. The characteristics of the activities proposed to the subjects were mainly from the hippotherapy program, exploring the physical therapy potential of the horse. The individual ability to complete tasks was respected, and the level of difficulty increased gradually. The final stage of the session, the disconnection stage, lasted 10 minutes. In this stage, the activities on the back of the horse were finished, and another sequence of ground stretching was conducted.

The activities were performed in pairs and assisted by skilled professionals, and the priority was to keep the same horse for each participant throughout the treatment. Two horses that were trained for hippotherapy were used: a 5-year-old female, with no specific breed, 155 cm height at the withers, body mass of 480 kg, and a 10-year-old male, American quarter horse, 158 cm at the withers, body mass of 510 kg, both with medium stride. The horses were equipped with blanket, open stirrups and reins, and they were conducted by auxiliary guides. All the safety procedures adopted during

the sessions were in accordance with the guidelines by ANDE-Brasil concerning the use of proper helmets and clothes.

Statistical analysis

Data were described in mean and standard deviation values. The Shapiro-Wilk test indicated normal distribution of data. The statistical treatment was performed with a completely casual design, with a varied number of repetitions in a 2³ factorial experiment (2 groups: IG and CG; 2 tests: pre and post; 2 sensory conditions: OE and CE). The variance analysis (ANOVA) was used by means of the F test and the post hoc Tukey test. All of the analyses were made with the SAS 8.0 software (Statistical Analysis System), and the statistical decision was made based on the significance level $p < 0.05$.

RESULTS

Clinical and demographic data of the subjects were presented in Table 1. The age ranged between 32 and 58 years old (44 ± 9.09) for IG, while in the GC it ranged from 43 to 54 years old (47.25 ± 5.31). The time of MS diagnosis was 8.57 ± 9.5 years for IG and 7.75 ± 7.22 years for GC. There were no statistical differences between the groups in relation to age and time of diagnosis.

The results of the evaluations of postural stability are presented in Table 2.

The multiple comparison of means showed significant differences between IG and CG ($p < 0.01$) in the investigated COP variables, with predominance of higher values in the IG. Significant differences between

Table 2. Postural control of patients with multiple sclerosis submitted to hippotherapy

Group	Sensory condition	Test	COP variables			
			AMPap (cm)	AMPml (cm)	VMap (cm/s)	VMml (cm/s)
IG	OA	Pré	2.85±0.93	2.21±1.19	1.44±0.56	1.30±0.75
		Pós	2.28±0.68	1.66±0.79	1.48±0.46	1.19±0.59
	OF	Pré	3.91±1.70	3.28±2.12	1.91±0.79	1.70±0.99
		Pós	3.02±0.84	2.17±0.99	1.85±0.70	1.19±0.41
CG	OA	Pré	1.58±0.35	0.96±0.43	0.83±0.19	0.62±0.30
		Pós	1.89±0.99	0.96±0.63	0.97±0.28	0.72±0.18
	OF	Pré	2.39±1.71	1.41±0.67	0.99±0.27	0.69±0.26
		Pós	2.61±1.37	1.08±0.44	1.33±0.35	0.84±0.15

COP: Center of pressure; IG: Intervention Grupo; CG: Control Group; OE: open eyes; CE: closed eyes; AMPap and AMPml: amplitude of COP displacement in the anterior posterior and medial lateral directions, respectively; VMap and VMml: mean speed of the COP displacement in the anterior posterior and medial lateral directions, respectively.

the sensory conditions were observed for both groups ($p < 0.01$), which presented lower performance with the privation of visual information. Interactions between pre and post-test and IG and CG were observed in the AMPap (5.07_p, $p < 0.01$) and VMml (5.50_p, $p = 0.02$). Tukey's test was used to locate the significances within these interactions.

Figure 1 illustrates the distribution of AMPap (A) and VMml (B) values for IG and CG.

When the distributed values of IG and CG are compared, it is possible to observe the prevalence of higher AMPap (A) values in the initial IG test. The post-test indicates the significant reduction of IG values, after the intervention period, while the CG kept a constant behavior in both tests. The Tukey's test allowed to observe that with the reduction of AMPap values in the IG, identified after intervention, the statistical differences between the groups were attenuated. The presence of the letter "ab" combined in the IG indicates the parity of values for both groups in the post-test.

The same considerations apply to VMml (B), which even demonstrating lower values presented a similar behavior to AMPap in both groups and tests.

DISCUSSION

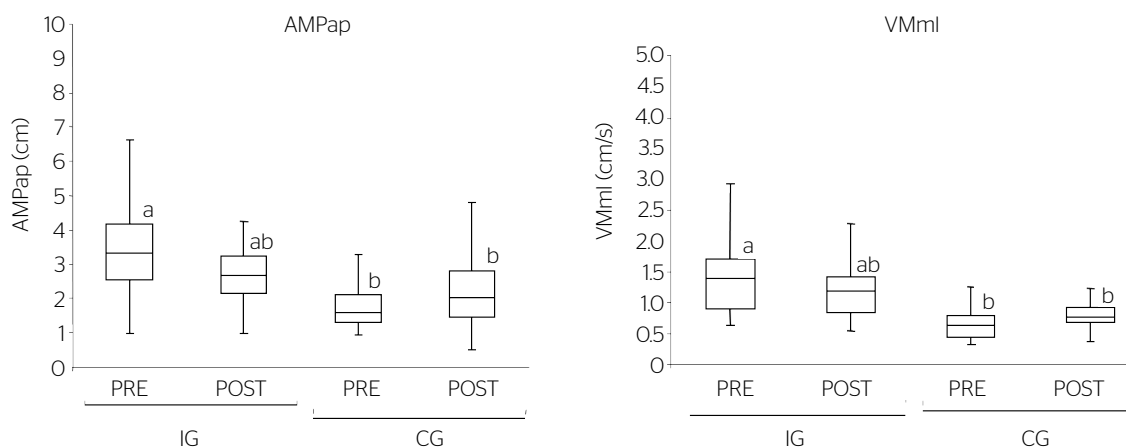
This study aimed to verify if the hippotherapy promotes changes in the postural stability of MS patients. To sum up, it was observed that the IG manifested a more compromised postural stability than the CG in the initial

test. Both groups presented lower performance when the visual information was suppressed. After intervention, the IG was capable of reducing the values of the analyzed variables, showing statistically significant differences for AMPap and VMml, while the CG maintained an unaltered behavior.

We observed that, regardless of the group, the greater oscillations and speeds prevailed in the anterior posterior direction (A-P). Similar studies observed postural instability in patients with MS submitted to different assessment conditions, including the quasi-static erect position^{6,10,11}. When compared with healthy controls, subjects with MS manifest more oscillation in both movement planes¹¹, with predominance of higher values in the A-P direction^{8,11}.

The IG reduced the values of all analyzed variables after the intervention, providing indications of better response for postural control. However, this behavior can only be confirmed for AMPap and VMml. For CG, the behavior remained unaltered. The results of the study confirm findings that observed significant improvement in the postural balance in MS after interventions using hippotherapy^{20,23}. It is worth to mention that these studies used the Berg scale.

By suppressing the visual information, both groups presented lower performance in the COP variables. When comparing MS patients with healthy controls, Porosinska et al.¹⁰ observed that while the healthy pairs were able to adapt their postural stability even without a visual reference, the privation of such information significantly affected those with MS.



Tukey's test; different letters indicate significant differences between the means. AMPap: amplitude of anterior posterior displacement; VMml: mean speed of the medial lateral displacement; IG: Intervention Group; CG: Control Group.

Figure 1. Distribution of amplitude of anterior posterior displacement and mean speed of the medial lateral displacement, for Intervention and Control Groups, pre and post-intervention.

As a response to the compromise of various systems, MS patients present with distortions in sensory integration^{11,16}, and they may experience functional deteriorations, even in the absence of clinical recurrence⁹. In an attempt to minimize such compromise, different rehabilitation strategies are used^{3,14,16,17}; however, not all of them have their efficacy confirmed. Cattaneo et al.²⁴ observed that exercises that use sensory strategies triggered better response in postural balance than aerobic and resistance exercises. In this context, hippotherapy is considered as a multisensory approach to treat for neurological diseases. This happens because the riding position, associated with the movement produced by the horse stride, requires constant postural adjustments; combined to the dissociation of the pelvic and scapular waists, they lead to reactions of trunk correction and tonic adjustments that act dynamically in the search for stability and postural control^{19,20}.

The results found in this study corroborate most of the findings that investigated the influence of the stimulation produced by hippotherapy in the most different neurological disorders. When the effect of stimulation on variables that influence postural control is analyzed, studies demonstrate the reduction of balance deficits and the adaptation of postural stability in MS patients^{20,23}.

CONCLUSION

The activities of sensory stimulation developed in the hippotherapy program were inserted in the routine of the participants as a complementary method to those in which they were already involved. The maintenance of CG scores and the favorable changes in the postural control of the IG suggest that hippotherapy can improve the postural control of MS patients. The difficulty to constitute a representative group of subjects with MS who would fit the study criteria, and then enable the randomization and /or the pairing of groups, as well as the homogeneity of neurological functions, makes it difficult to state that hippotherapy can improve the postural control of MS patients. However, the findings in this study reinforce literature, which supports the use of hippotherapy as a potential intervention for the postural control disorders in patients with MS.

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