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Artigo Original

Electromyographic analysis of children with intellectual disability during hippotherapy compared to independent gait

Análise eletromiográfica de crianças com deficiência intelectual durante a hipoterapia em comparação com a marcha independente

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Janaine Brandão Lage[1]* ORCID 0000-0002-1712-5593, Domingos Emanuel Bevilacqua Junior[2] ORCID 0000-0002-3423-2526, Mariane Fernandes Ribeiro[3] ORCID 0000-0002-8066-6771, Gabriel Antonio Nogueira Nascentes[4] ORCID 0000-0002-8934-6619, Vicente de Paula Antunes Teixeira1 ORCID 0000-0001-9431-7727, Ana Paula Espindula1 ORCID 0000-0002-9282-4482

ABSTRACT

Objective: analyze the electrical activity of muscles of trunk and lower limbs of children with Intellectual disability (ID) during hippotherapy compared to independent gait before and after 15 sessions. **Material and Methods:** eight children with ID and mean age of 11 ± 1.69 years participated. Hippotherapy sessions were performed for 30 minutes, once a week, with horse riding equipment blanket without foot support in the stirrups. The surface electromyography was used to access muscles activity during hippotherapy and gait and between pre- and post- 15 sessions. **Results:** when comparing hippotherapy to gait, there was greater muscle activity during gait, regardless of the moment analyzed, pre- or post-session ($p<0.05$). However, when comparing pre- to post-sessions moments, during gait there was a significant decrease in muscle activity ($p<0.05$) after sessions, while, in hippotherapy was observed a significant increase ($p<0.05$) after sessions. **Conclusion:** the electromyographic activity of trunk and lower limbs of children with ID is greater during gait compared to hippotherapy, regardless of the moment, reporting the beneficial effects of hippotherapy from the integration of musculoskeletal, sensory and neural systems on muscle behavior during independent gait.

Keywords: Intellectual disability. Electromyography. Equine-Assisted Therapy.

1 Federal University of Triângulo Mineiro, Brasil.

2 Louth County Hospital, UK

3 College Patos de Minas, Brasil

4 Federal Institute of Triângulo Mineiro, Brasil

***Corresponding author:** Frei Paulino, 30. Abadia. 38025-180. Uberaba, Minas Gerais, Brasil. Email: ja.bl@terra.com.br

RESUMO

Objetivo: analisar a atividade elétrica dos músculos do tronco e membros inferiores de crianças com deficiência intelectual (DI) durante a hipoterapia em comparação com a marcha independente antes e após 15 sessões. **Materiais e Métodos:** participaram oito crianças com DI e idade média de 11 ± 1,69 anos. As sessões de hipoterapia foram realizadas por 30 minutos, uma vez por semana, com material de montaria manta sem apoio dos pés nos estribos. A eletromiografia de superfície foi utilizada para avaliação da atividade muscular durante a hipoterapia e marcha e entre os momentos pré e pós 15 sessões. **Resultados:** ao comparar a hipoterapia com a marcha, houve maior atividade muscular durante a marcha, independente do momento analisado, pré ou pós-sessão ($p < 0,05$). Porém, ao comparar os momentos pré e pós-sessão, durante a marcha houve diminuição significativa da atividade muscular ($p < 0,05$) após as sessões, enquanto na hipoterapia foi observado aumento significativo ($p < 0,05$) após as sessões. **Conclusão:** a atividade eletromiográfica de tronco e membros inferiores de crianças com DI é maior durante a marcha em relação à hipoterapia, independente do momento, relatando os efeitos benéficos da hipoterapia a partir da integração dos sistemas musculoesquelético, sensorial e neural no comportamento muscular durante a marcha independente.

Keywords: Deficiência intelectual. Eletromiografia. Terapia assistida por cavalos.

INTRODUCTION

Intellectual disability (ID) according to the American Association for Intellectual Disability and Development is defined as the inability of intellectual functioning and adaptive behavior, which has significant limitations and occurs up to the age of 22, manifested through conceptual adaptive skills (cognitive function), social and practical1. Intellectual functioning corresponds to general mental aptitude, that is, intelligence, which includes cognitive functions, learning and reasoning, as well as language, motor skills and social aspects, such as, independence, responsibility and self-esteem[1,2].

Worldwide, it is estimated that more than a billion people have some type of disability or inability, which represents 15% of the population. However, ID corresponds to 5% of the population[3]. In Brazil, according to the last census, there are more than two million people with ID, which represents around 1.4% of the population[4].

According to the Diagnostic and Statistical Manual of Mental Disorders - DSM-55, the International Classification of Diseases - CID-106 and the Abbreviated Wechsler Intelligence Scale - WASI2, ID is classified into four levels of severity based on the intellectual quotient (IQ): mild (IQ 50-55 to approximately 70), moderate (IQ 35-40 to 50-55), severe (IQ 20-25 to 35 -40) and deep (IQ below 20 or 25).

The different levels of commitment result in changes in adaptive functioning, which influences the performance of activities of personal independence and social responsibility, whether in the skills of daily living, communication, social interaction and school and/or professional development[5,7]. Thus, ID can present impairments in balance, locomotion and coordination during more complex movements[8,9,10] and consequently manifest an altered gait with characteristics of extended and dragged support base[11]. A dynamically efficient and independent gait occurs from the continuous integration between the musculoskeletal, sensory and neural systems, associated with adequate muscle strength and joint mobility, as well as with an efficient neuromuscular control[12].

Hippotherapy has been indicated as a treatment method for children with ID because it is a resource that uses the horse as a kinesiotherapeutic instrument and covers the individual in his biopsychosocial context[13]. Sensorimotor stimulation through three-dimensional movement, provided by the horse during its step[14,15], promotes better performance in motor skills such as coordination, balance, agility[16] and flexibility of children with ID[17].

The horse step is a natural movement of the horse, rolled or marched, which features rhythm,

symmetry and four-stroke marking (four altered touches of the horse's limbs when touching the surface), being considered the basic movement most used in hippotherapy[18].

During the horse step, the horse performs a sequence of simultaneous movements comprising the anteroposterior, laterolateral and craniocaudal axes and a rotation of the pelvic girdle triggered by the lateral inclinations of the horse that result in the three-dimensional movement, which is transmitted to the individual through the contact between the horse's back and the horse riding equipment[14,15,19]. In this sense, studies claim that this three-dimensional movement triggered by the horse, can be interpreted as similar to the movement of the pelvis during human gait, being able to promote to the individual, during the mount, sensory and motor stimuli favorable to the man's gait[19].

Thus, this research was necessary due to the clinical implication and search for scientific evidence about the electromyographic analysis of trunk and lower limbs of children with ID during hippotherapy compared to independent gait, as well as the scarcity of research involving this population in the context of animal-assisted therapy. As a hypothesis, it was established that hippotherapy would provide an increase in the muscle electric activity of trunk and lower limbs with a pattern similar to the independent gait of these individuals.

However, the present study aimed to analyze the muscles electrical activity of trunk and lower limb of children with ID during hippotherapy compared to independent gait, before and after 15 sessions.

MATERIAL AND METHODS

Analytical, quantitative and longitudinal study. The parents and/or guardians of the participants received clarifications regarding the objectives and procedures to be carried out by the research and later, signed the Informed Consent Form. According to the ethical precepts adopted by research with human beings, the study was approved by the Ethics Committee in Researches, according to the opinion 2.152.117/2017 and obtained the Brazilian Registry of Clinical Trials RBR-4C3FZ2. Following the regulations for research involving the production, maintenance and/or use of animals for research purposes, it was approved by the Ethics Committee on the Use of Animals 426/2017.

Participated in the study, eight children diagnosed with moderate ID according to the WASI instrument[2], with a mean age of 11 ± 1.69 years, both genders and independent gait. The children selected for the study were by convenience and based on the analysis from medical records made available by the institution and following the inclusion criteria: being properly enrolled in the institution, aged between eight and 14 years old, presenting an independent gait and an exclusive clinical diagnosis of moderate ID.

Exclusion and non-inclusion criteria were adopted: presence of uncontrolled seizures; scoliosis above 30°; hip dislocation; uncontrollable fear of the animal; associated syndromes/behavioral changes and difficulty in understanding commands and/or tasks requested.

The sessions in hippotherapy were performed in a horse riding therapy center with an area of approximately three thousand square meters, containing an area covered with concrete surface and accessibility platform for horse riding, with weekly frequency (1x/week) and duration of 30 minutes. At the end of five months, the survey covered 15 sessions, a number higher than most intervention studies with hippotherapy described in systematic reviews[20,21].

The selected horses had similar physical characteristics of weight and height 1.54 m/470 kg and 1.54 m/488 kg, respectively. The horse step was established for the hippotherapy program with a frequency of around 56 horse steps/minute and an average speed of one meter/second controlled by the guide. The mean speed was considered from the record of the time of 10 seconds necessary for the horse to cover a space of 10 meters.

It is worth mentioning that, during the entire data collection period, the two horses were kept according to the first care of each child, respecting the moments of rest and rest as a guarantee of the

animal's health conditions. The horse riding equipment used was the blanket (made of foam and covered with synthetic leather) with front range for upper limb support and without foot support in the stirrups[22].

To assess muscle electrical activity, surface electromyograph was used, a portable model EMG800RF from EMG System do Brasil®, with eight wireless channels, 14 bits of resolution in the acquisition of signals, electrical isolation of 5000 volts, capacity to acquire 2000 samples/second/channel and filtered with band pass filters of 5 and 500 Hz and common module rejection >120 dB, USB connected to the notebook.

According to the *Surface Electromyography for the Non-Invasive Assessment of Muscles* – SENIAM[23] for the placement of the electrodes adopted in the performance of the surface electromyography, the procedures to minimize interference and better fixation of the electrodes such as skin cleaning with 70% alcohol and trichotomy (when necessary) were duly followed, as well as the specific recommendations regarding the locations of each musculature analyzed bilaterally (multifidus, rectus abdominis, rectus femoris and anterior tibialis), with a distance of two centimeters from center to center between the self-adhesive disposable electrodes, drop model, adult size (37 mm x 42 mm), descarpack®.

Electromyographic collections (EMG) during hippotherapy and independent gait were performed before and after 15 sessions, in a space covered with concrete surface and fixed marking on the ground (approximately eleven linear meters) used to determine the space in relation to the EMG data collection time, both set at 30 seconds. Thus, the first collection was carried out before the first session, initially with independent gait and soon afterwards in hippotherapy (first minute of mount), characterizing the pre-session moment. The post-session moment was defined for EMG data collections performed after 15 sessions in both hippotherapy and independent gait, following the initial procedures and criteria. The data obtained in the EMG record were presented in RMS microvolts (Root Mean Square) due to the comparison of an individual with themselves.

Statistical analyzes were performed using the Statistica Software, version 10.0®. For normality of data, the Shapiro-Wilk test was used, for homogeneity of variances, the Bartlett test, for comparison of data hippotherapy and gait (pre- and post-session), the t-paired test for data with normality and homogeneity or test of Wilcoxon for non-normal and non-homogeneous data. For the analysis of multiple variables, the Kruskal-Wallis test was followed by the Dunn post-test (cases with non-normal distribution). As statistically significant differences, $p<0.05$ was adopted.

RESULTS

When comparing hippotherapy to gait, at the pre-session moment, all the muscles analyzed obtained greater electrical activity during gait, with significant results for right anterior tibialis ($p=0.001$), right and left rectus femoris, left anterior tibialis and multifidus right and left ($p=0.012$). Likewise, in the post-session moment, the results also showed higher values for gait in all the analyzed muscles, with significance for the right anterior tibial musculature ($p=0.004$), right multifidus ($p=0.007$), left anterior tibial and multifidus left ($p=0.012$) and right rectus femoris ($p = 0.018$) (Table 1).

Table 1. Comparative EMG analysis between conditions, hippotherapy and gait, during the pre- and post-sessions moments.

Moments/Musculature	Hippotherapy	Gait	p value
Pre-session			
Rectus femoris R	**9,72 ± 3,84**	**42,23 ± 15,78**	**0,012***
Rectus femoris L	**7,85 ± 1,41**	**21,57 ± 12,34**	**0,012***
Anterior tibialis R	**8,70 ± 1,77**	**17,76 ± 5,36**	**0,001***
Anterior tibialis L	**9,61 ± 3,08**	**38,62 ± 12,17**	**0,012***
Abdominal R	8,34 ± 1,41	10,50 ± 3,04	0,097
Abdominal L	9,24 ± 1,73	13,20 ± 4,89	0,093
Multifidus R	**10,60 ± 5,63**	**24,51 ± 11,89**	**0,012***
Multifidus L	**8,75 ± 1,05**	**23,47 ± 9,60**	**0,012***
Post-session			
Rectus femoris R	**12,51 ± 6,15**	**30,33 ± 14,04**	**0,018***
Rectus femoris L	10,95 ± 3,32	15,53 ± 4,21	0,067
Anterior tibialis R	**9,47 ± 2,08**	**18,54 ± 5,98**	**0,004***
Anterior tibialis L	**11,63 ± 5,70**	**31,61 ± 7,79**	**0,012***
Abdominal R	8,82 ± 0,81	9,71 ± 1,36	0,123
Abdominal L	10,28 ± 1,58	11,08 ± 2,23	0,462
Multifidus R	**9,20 ± 1,71**	**18,97 ± 8,57**	**0,007***
Multifidus L	**9,86 ± 2,00**	**22,33 ± 16,46**	**0,012***

* p<0,05. teste t-pareado ou Wilcoxon. R (right). L (left).

Source: Lage, 2020.

Based on the comparative analyzes between the pre- and post-sessions moments, specific to each condition, during hippotherapy there was an increase in electromyographic activity in most of the muscles analyzed at the moment of post-session, but with significance only for the left rectus femoris (p=0.012). On the other hand, in the gait analysis, there was a reduction in the electrical activity of the analyzed musculature, with significance for the right rectus femoris (p=0.017), right multifidus (p=0.024) and left anterior tibial (p=0.028) in the post-session (Table 2).

Table 2. Comparative EMG analysis between the pre- and post-sessions moments for each condition (hippotherapy and gait).

Condition/Musculature	Pre-session	Post-session	p value
Hippotherapy			
Rectus femoris R	9,72 ± 3,84	12,51 ± 6,15	0,093
Rectus femoris L	**7,85 ± 1,41**	**10,95 ± 3,32**	**0,012***
Anterior tibialis R	8,70 ± 1,77	9,47 ± 2,08	0,368
Anterior tibialis L	9,61 ± 3,08	11,63 ± 5,70	0,093
Abdominal R	8,34 ± 1,41	8,82 ± 0,81	0,484
Abdominal L	9,24 ± 1,73	10,28 ± 1,58	0,177
Multifidus R	10,60 ± 5,63	9,20 ± 1,71	0,779
Multifidus L	8,75 ± 1,05	9,86 ± 2,00	0,132
Gait			
Rectus femoris R	**42,23 ± 15,78**	**30,33 ± 14,04**	**0,017***
Rectus femoris L	21,57 ± 12,34	15,53 ± 4,21	0,093
Anterior tibialis R	17,76 ± 5,36	18,54 ± 5,98	0,758
Anterior tibialis L	**38,62 ± 12,17**	**31,61 ± 7,79**	**0,028***
Abdominal R	10,50 ± 3,04	9,71 ± 1,36	0,568
Abdominal L	13,20 ± 4,89	11,08 ± 2,23	0,187
Multifidus R	**24,51 ± 11,89**	**18,97 ± 8,57**	**0,024***
Multifidus L	23,47 ± 9,60	22,33 ± 16,46	0,208

* p<0,05. teste t-pareado ou Wilcoxon. R (right). L (left).

Source: Lage, 2020.

DISCUSSION

Based on the objectives outlined for this study to analyze the electromyographic activity of trunk and lower limbs of children with ID during hippotherapy compared to independent gait before and after 15 sessions, the benefits from equine-assisted therapy through different results observed in the pattern of muscle activation between hippotherapy and gait, validating part of the initial hypothesis. However, the hypothesis that there would be similar electrical muscle activity between hippotherapy and independent gait was rejected.

The muscular behavior observed during gait in comparison to hippotherapy, regardless of the moment (pre- or post-session), infer that the orthostatic positioning and against gravity can influence the results indicated. In gait, there was greater electrical activity of all the muscles analyzed, with emphasis on the rectus femoris, anterior tibialis and bilaterally multifidus muscles. According to studies, during gait, the muscles of trunk play a fundamental role in postural stability, being constantly activated[24], while the rectus femoris and anterior tibialis are the main muscles that actively participate in joint movements of the lower limbs, the rectus femoris as a hip flexor and knee extensor, and the anterior tibialis as an ankle flexor and supinator[25].

In hippotherapy, the sitting posture using the front range as a support for upper limbs may have contributed to greater trunk stability and balance of individuals and, consequently, to less muscle activation in relation to gait. This muscular behavior can also be related to aspects related to the concrete surface where electromyographic care and collections were performed, as well as the horse step adopted in the present study, which infer a lesser range of displacement and anteroposterior and lateral average speed during the mount[26,27,28].

According to studies carried out with healthy young individuals in hippotherapy, the mount performed on different surfaces (asphalt, grass and sand) has significantly less anteroposterior displacement amplitudes in the asphalt due to its greater resistance in relation to the sand that promotes greater penetration of the legs of horse in the surface and consequently less resistance[26,28]. The speed of horse step influences the horizontal and vertical displacement of the horse's spine and promotes greater postural adjustments, balance and coordination, considering that its interference has direct relation with the length and frequency of the horse step[27].

When comparing the pre- to post-sessions moments, specific to each condition, it was found that during hippotherapy there was an increase in electromyographic activity after 15 sessions. On the other hand, during the gait there was a reduction in this activity after the 15th session. The differences observed in the pattern of muscle activation between hippotherapy and gait may indicate improvement in the behavior of the analyzed muscles in terms of recruiting and reorganizing their fibers and, consequently, in their ability to perform independent gait.

During riding in hippotherapy the individual needs to perform postural adjustments constantly due to the vertical and horizontal displacements produced by the horse step[28], thus promoting greater activation of the trunk and lower limb muscles[29]. In this context, research shows that the knee angle regarding the positioning of the feet in the stirrups interferes with the electrical activity of the paravertebral and abdominal muscles, producing less contraction intensity with the knee flexed at 140° compared to the 120° and 100° angles[30].

It is worth mentioning that in the present study, children used the blanket as horse riding equipment in hippotherapy, with findings similar to the study by Ribeiro and collaborators[29] developed with typical young adults. Both obtained increased muscular activity of the trunk and lower limbs after intervention with hippotherapy, however, differing as per the positioning of the feet in the stirrups.

The repetitive and cyclical movement that the horse performs during horse step in hippotherapy reproduces a pelvis movement pattern similar to human gait[19,31]. Research shows that motor practice and repetition of cyclical movements for children with disabilities are considered of extreme importance for the development, maintenance and improvement of neural and motor pathways[32,33].

However, during the comparative analyzes between the pre- and post-sessions specific for gait, the muscles evaluated showed a reduction in electromyographic activity, mostly after the 15 sessions, with emphasis on the right rectus femoris, left anterior tibial and right multifidus. As observed in a study on the benefits of equine-assisted therapy in the muscle reaction function of adolescents with ID, after 14 weeks sessions, the subjects showed improvement in the muscle reaction time and in the reduction of the muscular activity of the biceps and rectus femoris[34]. Such results refer to the discussions initially considered, that the lower muscle activation after intervention with hippotherapy can infer a neurofunctional reorganization with better performance of the trunk and lower limb muscles.

The study in question has some limitations, including the monitoring of the electrical activity of the trunk and lower limb muscles after a period of five months, maintaining the frequency and duration of appointments. However, it presents significant and favorable results regarding the neuromuscular aspects of children with ID undergoing hippotherapy, contributing to a pattern of muscle activity with better performance during the gait of this population.

CONCLUSION

In this way, we can conclude that the electromyographic activity of the trunk and lower limb muscles of children with ID is greater during gait compared to hippotherapy. However, after 15 sessions there was an increase in muscle activation during hippotherapy and a reduction in this activity during gait, thus reproducing the beneficial effects of hippotherapy from the integration of musculoskeletal, sensory and neural systems on muscle behavior during independent gait.

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Conflict of interest

There is no conflict of interest.

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