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Activation of lower limb muscles with different types of mount in hippotherapy

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A B S T R A C T

Objectives: To analyze muscle activation of lower limbs (LL) of subjects in hippotherapy sessions.
Methods: The study included 10 healthy subjects, five male and five female, with an average age of 24.03 (±4.06) years. Subjects underwent four hippotherapy sessions of 30 min with interval of one week, and each session was performed with a different type of mount material in the following order: 1st performed with saddle and feet in the stirrups (S1), 2nd with saddle and feet off the stirrups (S2), 3rd with blanket and feet off the stirrup (S3) and 4th with blanket and feet in the stirrups (S4). Surface electromyographies were performed at 1, 10, 20 and 30 min of session, and the electrodes were placed on muscle bellies bilaterally on the muscles rectus femoris, vastus medialis, vastus lateralis and tibialis anterior.
Results: The analysis of muscle activity during these four sessions showed a significant difference in muscle recruitment in LL, and sessions with blanket and feet in the stirrups provided greater muscle activation of quadriceps and tibialis anterior with the horse at step gait ($p = 0.0002$).
Conclusion: The results suggest that feet positioned in the stirrups is a relevant factor for greater muscle recruitment in LL to maintain postural balance while riding, especially using a blanket as mount material for ride a horse.

1. Introduction

The use of horses as a form of rehabilitation dates back to centuries ago, with the first reports from the Ancient Greece. Since then, the benefits of riding horses have been increasingly known and reported, and today hippotherapy is used as a rehabilitation method in more than thirty countries (Granados and Agís, 2011). In Brazil, the practice of hippotherapy is regulated by the guidelines of the National Association of Riding Therapy (ANDE-Brazil, 2016).

In hippotherapy, through the horse's gait, the three-dimensional movements provided by the activity stimulate, in the practitioner's body, several sensory and neuromuscular stimuli that will directly affect the overall development and acquisition of motor skills, contributing to an improvement in the performance of daily, working, leisure and sports activities, providing a more productive social life (Medeiros and Dias, 2002; Torquato et al., 2013).

This therapeutic method promotes a multisensory activity through the rhythmic oscillation of the horse's croup. Postural reflex mechanisms are stimulated, combined with the decoupling of pelvic and shoulder girdles and constant tonic adjustments, resulting in the training of balance and coordination. Furthermore, this movement requires a global adaptive response of the practitioner, and provides various visual and vestibular information, contributing to the development of strength, muscle tone,

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flexibility, relaxation, proprioception, balance, learning, memory, concentration, cooperation, socialization, symmetry of muscle activity of the torso, balance in standing and motor coordination, especially the gross type, improving walking, running and jumping (Araujo et al., 2011; Menezes et al., 2013; Sanches and Vasconcelos, 2010). There are several studies in the literature that show the effects of hippotherapy on features as motor functions (Torquato et al., 2013), gross motor function, postural control (Champagne and Dugas, 2010; Tseng et al., 2013), postural stability and balance (Fernández-Gutiérrez et al., 2015) and space-time perception (Manikowska et al., 2013) of different types of study populations, as elderly individuals (Silveira and Wibelinger, 2011) or people with Down syndrome or cerebral palsy, and other neurological disorders such as multiple sclerosis, traumatic brain injury, learning difficulties and muscle dysfunction (Herrero et al., 2010; Menezes et al., 2013).

The numerous stimuli received by the practitioner reach the central nervous system via activation of receptors of the proprioceptive system, which also results in an inhibitory positioning of pathological patterns. This action contributes to the sensorimotor development that provide acquisitions as balance, body adjustments, movement coordination and movement precision (Pierobon and Galetti, 2008). In a survey using motion capture, a kinematic analysis was performed of the three-dimensional movements of the pelvis of children without disabilities on foot and sitting while in a riding simulator. The authors reported that, just as stimuli occurred for children without disabilities while riding, they might provide the same therapeutic benefits to individuals with disabilities who cannot move naturally. They also concluded that the amplitudes of pelvic displacement when walking were similar to the ones while mounting for the pelvic angle of the anteroposterior, mediolateral and superoinferior transverses (Brian et al., 2015). Some studies in healthy people show the effects of the horse walking and importance of these data for hippotherapy. Demonstrated that riding provided motor and sensory impulses, indicating that horse riding at a walking gait provides stimulation highly similar to that generated by human walking, and thus provides optimum treatment benefits to people with ambulatory difficulties (Uchiyama et al., 2011; Garner and Rigby, 2015).

Surface electromyography (EMG) is a noninvasive assessment method, which records the changes in muscle electrical activity during contraction and provides an objective and accurate assessment for scientific documentation and diagnostic. Electromyography registration requires a system comprising electrodes that capture the electrical potentials (activity) of muscle contraction, an amplifier that processes the electrical signal and a decoder that allows the graphical display and/or hearing of sounds (Espindula et al., 2015). In previous studies, it was noted that the mounting condition that provided a larger and more homogeneous muscle activation in stabilizing torso muscles for children with spastic hemiparesis was while riding in the saddle and with the feet in the stirrups (Espindula et al., 2012). On the other hand, for individuals with Down syndrome, riding in the blanket with the feet out of the stirrups favored increased recruitment of the abdominal and paraspinal muscles; however, the complexity of forming a representative group of children with Down syndrome that are suited to the proposed study prevents the assertion that hippotherapy improves the tone of all individuals with this syndrome (Espindula et al., 2014).

Considering the various stimuli provided by the horse, and in order to contribute to the literary enrichment on the practice of hippotherapy, an assessment on how the muscle activation of the lower limbs occurs in different types of riding is required, justifying this study. The hypothesis in question is that the use of blanket or saddle as riding material, as well as the position of the lower limbs, with feet in or out of the stirrups, can result in more or less muscle stimulation of the practitioner.

Thus, the objective of this research was to analyze muscle activation of the lower limbs while riding in hippotherapy sessions.

2. Materials and methods

This research was evaluated and approved by the Research Ethics Committee of the Federal University of the Triangulo Mineiro, under protocol number 2686.

2.1. Research subjects

This research is a pilot study of cross-sectional design. The sample comprised 10 healthy volunteer subjects, five male and five female, with an average age of 24.03 (±4.06) years. As inclusion criteria, the subjects could not be inserted in any other physical activity program, present orthopedic problems of the lower limbs or severe postural changes or present any other alterations that contraindicated hippotherapy.

2.2. Evaluation procedures

The electromyographic analysis was performed with a surface electromyography unit, model EMG800RF, of EMG System of Brazil®, with 8 wireless channels, 14-bit resolution in the acquisition of signals, electrical insulation of 5000 V. The signal recorded by the electrodes was amplified 2000 times and filtered with band pass filters of 5–500 Hz and common module rejection >120 dB. The electromyographer was connected to a CCE® notebook computer via USB port, and the software for registration and analysis was developed by EMG System of Brazil (Belo et al., 2009). After shaving and cleaning the skin with cotton soaked in 70% alcohol, 1 cm disc shaped bipolar surface electrodes (Ag/AgCl surface with foam and solid gel) connected to the preamps in a center-to-center interelectrode distance of 2 cm (Espindula et al., 2015) were placed on the muscles. The electrodes were positioned on the muscle bellies, according to the recommendations of the SENIAM Project (Surface Electromyography for Non-invasive Assessment of Muscles) (Hermes et al., 2000) bilaterally in the following muscles of the lower limbs: rectus femoris, vastus medialis, vastus lateralis, biceps femoris and tibialis anterior.

For normalization of electromyographic data, the muscle activity, which is represented by values of root mean square (RMS) in μV (microvolts) recorded during the sampling were divided by the maximal voluntary contraction (MVC) of the assessed muscles, in both LL. In MCV tests of rectus femoris, vastus lateralis and vastus medialis, corresponding to the quadriceps muscle, subjects were seated with their knees bent at 60° (Corrêa et al., 2011), receiving resistance in the distal region of the leg while performing a knee extension. For the assessment of the tibialis anterior, the same positioning was used and the subjects performed a dorsiflexion of ankle with resistance in the distal part of the foot. Three MCV repetitions were carried out, and the mean values were used to normalize the data. Thus, the value obtained for analysis was the root mean square of the normalized mean (RMSn): RMSn = RMS/CVM (Espindula et al., 2012).

In each session, the electromyographic recordings were performed at 5 moments, considered as 6 times (T): two records with the practitioner sitting on the back of the stationary horse, before and after the session, named sitting at the start (T1) and sitting at the end (T6) respectively; and four samplings during the session with the horse at slow gait, at the first minute (T2), tenth minute (T3), twentieth minute (T4) and thirtieth minute (T5).

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