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The impact of hippotherapy on the quality of trunk stabilisation, evaluated by EMG biofeedback, in children with infantile cerebral palsy

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ABSTRACT

Introduction: Damage to the central nervous system in children with infantile cerebral palsy (ICP) can cause aberrant and uncoordinated muscle contraction resulting in postural instability. Hippotherapy is a method of motor rehabilitation, rooted in neurophysiology, which utilizes the natural motion of a horse's gait to entrain trunk stability in the seated rider.
Aim: The aim of this research was to assess the effect of hippotherapy in improving trunk stability in children with spastic ICP.
Material and methods: The research was conducted on 24 children with ages ranging from 2 to 18 years (average age: 10.63 ± 4.95) who suffer with spastic ICP. Each child underwent physiotherapeutic assessment twice, an initial assessment at the start of the study period and a follow up assessment after 3 months of hippotherapy. All study subjects undertook 2 sessions of hippotherapy each week for a period of 3 months.
Results and discussion: An increase in the maximum tension of the rectus abdominis muscle was observed in 17 out of 24 participants (81%). Further analysis of response to therapy according to subtype of ICP revealed an improvement in 13 out of 16 children with spastic diparesis and in 3 out of 7 children with tetraparesis. Improved trunk stability was seen in 6 out of the 11 children who were mobile with a wheelchair, and in 11 out of 12 independently mobile children.
Conclusions: This study proves that hippotherapy has a significant impact on improving the trunk stability of children with ICP.

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1. Introduction

The term infantile cerebral palsy (ICP) dates back to the 19th century, but only during the last 20 years has a collective definition for this group of disorders been recognized.[1–3] The incidence of ICP is reported to be 1.5–3.0 cases per 1000 live births and the incidence has remained static in recent decades despite improvements in neonatal care.[4–6] ICP is described as a disorder of movement and posture and is usually classified according to the system proposed by Ingram.[7] Recognized subtypes include bilateral hemiplegia, bilateral spastic paralysis, hemiplegia, cerebellar ICP and extrapyramidal ICP. It is frequently accompanied by epilepsy, sight and hearing deficits, speech disorders, learning disability and disturbances of behaviour and emotion.[2,8,9] Damage to the central nervous system (CNS) causes aberrant and uncoordinated muscle contraction resulting in an inability of the postural muscles to respond appropriately to passive movements which causes central postural hypotonia.[1,6]

Hippotherapy is a method of motor rehabilitation which has its roots in neurophysiology. It makes use of the natural motion of a horse's walking gait to entrain trunk stability in the seated rider.[10]

There are three distinct horse gaits, walk, trot and gallop, but only the walking gait is used in hippotherapy. The motor impulses transmitted from the horse's limbs to its back are then transferred to the patient riding on the horse's back. The first therapeutic aim of hippotherapy is to achieve mobility of the pelvis in the sagittal plane which then allows transmission of the movement along the rider's spine. In attempting to maintain correct posture the rider's postural muscles must respond to these movements leading to improved strength and coordination. This improvement in muscle strength also helps to restore the normal, physiological curvatures of the spine.[10,11] It was hypothesized that due to described above mechanisms the hippotherapy intervention might improve trunk control and muscle coordination.

2. Aim

The aim of the research was to assess the impact of hippotherapy on trunk stability in children with spastic ICP.

3. Material and methods

The research was conducted on 24 children with ages ranging from 2 to 18 years (average age 10.63 ± 4.95) who suffered with spastic ICP. In total, 11 (46%) of the researched persons were aged between 7 and 12 years and 8 (33%) were aged between 13 and 18 years; 15 (62%) were female; 17 (71%) of the children had no mental impairment and 7 (29%) had slight or moderate impairment. Patients with mild mental retardation have IQ level 50–55 points to approximately 70 whereas moderate mental retardation means that IQ level is 35–55.

Study participants fell into three subtypes of ICP: 16 of the 24 (67%) suffered with diparesis, 7 (29%) suffered with tetraparesis, and 1 child (4%) suffered with hemiparesis.

Table 1 – Demographic and clinical characteristic of patients (*n* = 24).

Characteristic	Subtype
Age	
2–6 years	5
7–12 years	11
13–18 years	8
CP patterns	
Spastic	
Dipareza	16
Tetrapareza	7
Hemipareza	1
Dyskinetic	0
Hypotonic	0
Ataxic	0
Mixed	
Dyskinetic and spastic	0
Dyskinetic and hypotonic	0

In total, 12 (50%) children were independently mobile, 11 (46%) mobilized by wheelchair, and 1 (4%) walked with a frame; 18 (75%) of the study subjects were secured 'from below' (with the hippotherapist standing beside the horse), and 6 (25%) were secured 'from above' (with the hippotherapist sitting on the horse with the patient) (Table 1).

Study inclusion criteria were a diagnosis of spastic ICP and age up to 18 years. Exclusion criteria included any contraindication to hippotherapy: allergy, severe scoliosis, hip subluxation, severe seizure disorders, advanced osteoporosis, osteogenesis imperfecta, atlantoaxial instability, acute painful conditions.

Each child underwent physiotherapeutic assessment twice, at the start of the study period and again after three months of hippotherapy.

The assessment consisted of a general medical interview and measurement of the rectus abdominis muscle tension with an EMG biofeedback device. For the analysis of the muscle tension of rectus abdominis the Neuro Trac device for electrical assessment of the muscles was used. The examination consisted of placing two electrodes near the muscle attachments which detect increases and decreases in muscle tension within the feedback range (Fig. 1). A third electrode is

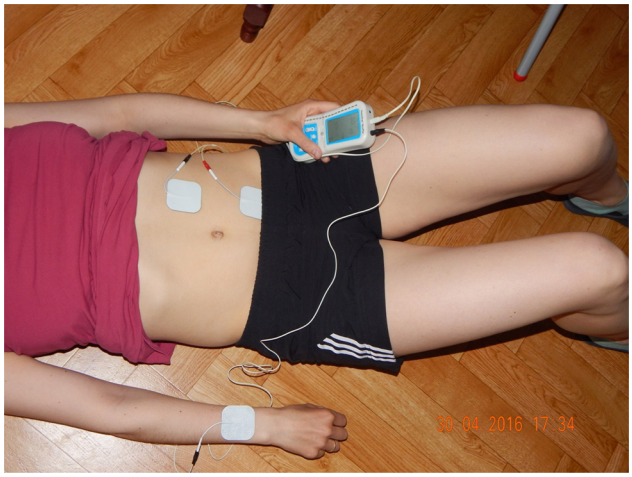

Fig. 1 – Position of superficial electrodes during EMG of rectus abdominis muscle.

placed in a random point over a bone, and it acted as a 'neutral ground.' A trial muscular contraction was performed by pulling the head towards the sternum in the supine position to calibrate the device.

All the children participated in hippotherapy activities for 3 months with sessions taking place twice a week in the stable Rohan at Rzeczna Str. in Reda. During the research period each child participated in a total of 24 hippotherapeutic sessions. Before commencing the cycle of classes the hippotherapist filled in a hippotherapy course card for every child.

4. Results

An increase in the maximum tension of rectus abdominis was observed in 17 out of 24 children (71%) (Table 2).

For each patient the difference in tension divergence (the difference between the tension during contraction and relaxation) in rectus abdominis was calculated between the first and second examination (Fig. 2).

Further analysis of therapy response according to subtype of ICP revealed an improvement in 13 out of 16 children with spastic diparesis and in 3 out of 7 children with tetraparesis (Table 3). The improvement was defined as the increase of control over rectus abdominis. The positive number expressing a difference in tension divergence was treated as the indicator for improvement of trunk stability.

Study participants fell into three mobility categories: those mobile in a wheelchair, those mobilising with a walking frame, and those who were independently mobile. Improvement in trunk stability was seen in 54% of children using a wheelchair and in 92% of patients who were independently mobile (Table 3).

Table 2 – Number of persons, in whom the increase of maximal tension in the straight muscle of abdomen was observed after the examination.

	N (%)
Increase	17 (71%)
No increase	6 (29%)

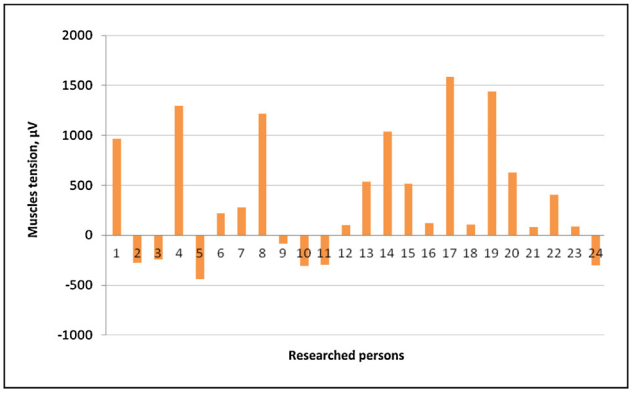

Fig. 2 – The difference of tension divergence in the straight muscle of abdomen after performed examinations.

Table 3 – Comparison of trunk stabilisation in terms of the type of paresis and way of moving.

	Improvement	No improvement
Type of paresis		
Diparesis ($n = 16$)	13 (81%)	3 (19%)
Hemiparesis ($n = 1$)	1 (100%)	0 (0%)
Tetraparesis ($n = 7$)	3 (43%)	4 (57%)
Way of moving		
Using wheelchair ($n = 11$)	6 (54%)	5 (45%)
Using walking frame ($n = 1$)	1 (100%)	0 (0%)
Walking on their own ($n = 12$)	11 (92%)	1 (8%)

5. Discussion

Previous research into the role of hippotherapy in treating children with ICP has focused on the impact of therapy on the children's general motor activity assessed using the Gross Motor Function Measure (GMFM) scale.[12–15] All authors acknowledge the positive influence of hippotherapy on motor activity of children with ICP. No improvement in general motor activity would be possible without improving trunk stability.[14] This research proves this assertion.

The results presented here are also supported by the research of Shurtleff et al.[13] in which, by using video recordings and measuring the anteroposterior translation of the spinal column, the stability of the trunk was assessed after hippotherapy in children with spastic ICP. Maintaining stability of the upper spine against the movement of the horse, transmitted via the pelvis to the spine, is thought to be the mechanism by which trunk stability is improved. The results obtained from our research confirm that, after regularly performed hippotherapy, there is a progressive increase in the activity of postural muscles.

In Bertoli's study it was demonstrated that therapeutic horse riding has more significant influence on posture control in children with diparesis than in those with tetraparesis.[14] Although our study group was more diverse than in Bertoli's study, both in terms of degree of learning impairment and of ICP subtype, this study also showed a significantly greater improvement in trunk stability amongst study participants with diparesis than with tetraparesis.

Although patients with both tetraparesis and diparesis typically have reduced trunk muscle tone in cases of tetraplegia, where head control is also likely to be poor, response to therapy is worse.[14,16] Similarly, the response to therapy seen amongst the children in wheelchairs, the majority of whom suffered with tetraparesis, was also worse. Trunk stability improved in only 6 out of 11 children using a wheelchair compared to 11 out of 12 children who were independently mobile.

The EMG analysis performed on the rectus abdominis muscle showed a significant increase in the difference between the muscle tension during contraction and relaxation. This suggests an improvement in the efficiency of muscular contraction which contributes to improved trunk stability. The increased amplitude of contraction demonstrated by EMG analysis equates to increased muscle strength.

This conclusion is substantiated by the research of Eek et al. which aimed to examine muscle strength in children with ICP using a hand myometer.[16] This research proved that an increase in the amplitude of muscle tension equates to increased muscle strength.

Benda et al. has previously utilized EMG for evaluating children with ICP after hippotherapy but this research analysed the symmetry of muscular activity rather than muscle tension.[17] This was achieved by placing electrodes over the thoracic and lumbar spine and on the abductors and adductors of the thigh. This study showed symmetry of postural muscular activity was improved in children undertaking hippotherapy (64.6%) compared to control children examined on a static barrel (12.8%). An increase in the symmetry of muscle activity suggests an improvement of posture control.[17]

6. Conclusions

This study proves that hippotherapy has a significant impact on improving the trunk stability of children with ICP.

Greatest improvement was shown in children who were independently mobile.

Children with spastic diparesis showed a greater improvement than children with other ICP subtypes.

Conflict of interest

None declared.

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