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Does hippotherapy improve gross motor function in children with cerebral palsy?

Victoria I. Bockius
Philadelphia College of Osteopathic Medicine

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Victoria I. Bockius, PA-S

A SELECTIVE EVIDENCE BASED MEDICINE REVIEW

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ABSTRACT

OBJECTIVE: The objective of this selective EBM review is to determine whether or not "Does hippotherapy improve gross motor function in children with cerebral palsy?".

STUDY DESIGN: A systematic review of three randomized controlled trials (RCTs), with one being a randomized crossover trial. All three were published between 2015 and 2018.

DATA SOURCES: Three RCTs published in peer-reviewed journals were chosen from PubMed. The studies were selected based on their relevance to the clinical question.

OUTCOMES MEASURED: The outcome measured was improvement in gross motor function. Either hip adductor spasticity using Modified Ashworth Scale (MAS) or the Gross Motor Function Measure 66 (GMFM-66) was used to assess the outcomes. Scores were assessed before and after treatments were conducted.

RESULTS: The statistical analyses used were mean change from baseline and p-values. In the RCT conducted by Lucena-Antón et al., hippotherapy led to a reduction in hip adductor spasticity by an average of 0.27 in the left and 0.45 in the right. In the randomized crossover trial led by Deutz et al., the mean change in GMFM-66 between hippotherapy intervention period and no hippotherapy period was 2.99 in the early treatment group (ETG) and 1.60 in the late treatment group (LTG). In the RCT conducted by Kwon et al., the mean change in GMFM-66 from baseline in the hippotherapy group was 2.7. All three studies found a statistically significant difference between the intervention and the control group with a p-value <0.05.

CONCLUSIONS: All three studies found statistically significant improvement in gross motor function in the intervention group compared to the control group. The results of this selective review suggest that hippotherapy is more effective in improving gross motor function in children with cerebral palsy than conventional physical therapy alone. Further studies should be conducted in the United States comparing the effectiveness of hippotherapy to the standard physical therapy administered in the States.

KEY WORDS: hippotherapy and cerebral palsy

INTRODUCTION

Hippotherapy is equine-assisted therapy for therapeutic or rehabilitation purposes that focuses on the benefits of improving postural control, balance, and strength. Hippotherapy may be beneficial for those with conditions such as, cerebral palsy, autism, developmental delay, stroke, multiple sclerosis and traumatic brain injuries. Cerebral palsy is a group of movement and posture development disorders that occur during the fetal or infant brain development and is non-progressive.[1] Cerebral palsy is the most common motor disability in children. Between 2 and 2.5/1,000 live births are born with cerebral palsy.[1] That is around 10,000 babies born with cerebral palsy per year in the United States. Having a child with cerebral palsy requires the help of numerous resources and is financially demanding. In 2019, the annual Medicaid cost per child with cerebral palsy was $22,383.[2] The lifetime cost of an individual with cerebral palsy is estimated to be nearly $1 million.[3] Children with cerebral palsy require the use of many healthcare services, averaging 23 annual specialized care visits and four emergency services visits.[4]

In most cases of cerebral palsy, the exact cause is unknown. Possible causes are genetic abnormalities, congenital brain malformations, maternal infections or fevers, episodes of fetal or infant hypoxia. It is non-progressive and there is no cure for cerebral palsy, but medications, physical therapy and surgeries can help improve motor skills. Cerebral palsy leads to varying degrees of deficiencies, medical, social and educational implications.[1] While some individuals with cerebral palsy may be able to earn incomes and live independently, many have cognitive issues which limit them. There are four main types of cerebral palsy classified as - spastic, dyskinetic, ataxic and mixed. Spastic is the most common type and is due to hypertonia leading to stiff muscles that are difficult or impossible to move. The increased muscle tone in the hip

muscles along with the associated sensory deficits, such as poor proprioception and cutaneous sensation, can lead to poor postural tone and balance.[1]

Treatment for cerebral palsy is aimed at improving quality of life and gaining the greatest level of independence possible for the individual. Muscle relaxants such as baclofen, tizanidine, dantrolene, or diazepam can aid in relieving stiff muscles. Physical therapy can help reduce muscle tension and allow for greater control of movements. Occupational therapy can teach techniques in order to independently perform activities of daily living. Speech and language therapy will assist in language skills such as building vocabulary and grammar. Orthopedic surgeries, such as tendon release surgery, help to improve mobility. Selective dorsal rhizotomy, which targets and destroys certain nerve roots, can be done for severe cases of spasticity when other treatments have failed.

Hippotherapy is an alternative form of physical therapy that is more engaging and exciting for children with cerebral palsy. The horse's seat is a dynamic therapeutic tool that provides three-dimensional impulses to the rider's neuromuscular system. The three-dimensional movements of a walking horse stimulates normal pelvic movements that closely mimic those during ambulation in the rider.[6] This allows for development of postural control, improves trunk strength, control, and balance.[1,5] It also addresses weight-bearing shifts and improves motor planning.[6] The head, arms and trunk segment are balanced over the lower limbs, making the hips the center for balance control. Since spasticity of hip muscles is directly related to hip motion, a reduction in hip adductor spasticity will cause a gain in postural control and balance.[1] This paper evaluates two randomized controlled trials and one randomized crossover trial evaluating the efficacy of hippotherapy for gross motor function improvement in children with cerebral palsy.

OBJECTIVE

The objective of this selective EBM review is to determine whether or not "Does hippotherapy improve gross motor function in children with cerebral palsy?".

METHODS

Studies were chosen through PubMed and selected based on if they answered a clinically relevant question and if it included a patient-oriented outcome. The studies were also chosen based on inclusion and exclusion criteria. The study had to be a randomized control trial published in 2011 or later, with a study population consisting of children with cerebral palsy. Any studies that were simulations or published prior to 2011 were excluded. The keywords that were used in searches were "hippotherapy" and "cerebral palsy". All articles were published in peer reviewed journals and published in English. The statistical analysis used in these studies were mean change from baseline as well as assessing statistical significance using p-values (significance level set to <0.05).

The population being studied includes children with cerebral palsy. The specific demographics of each study selected can be found below in Table 1. A comparison between hippotherapy along with conventional physical therapy to a control group receiving conventional physical therapy alone or with aerobic home therapy was investigated. The outcome measured was improvement in gross motor function. The types of studies chosen were two RCTs and one randomized control crossover trial.

OUTCOMES MEASURED

The outcome measured was improvement in gross motor function. In the study conducted by Lucena-Antón et al., hip adductor spasticity was measured using Modified Ashworth Scale (MAS).[1] The MAS score is the most widely used scale to assess muscle hypertonia.[1] It uses the

Table 1. Demographics and Characteristics of Included Studies

Study	Type	# Pts	Age (Years)	Inclusion Criteria	Exclusion Criteria	W/D	Interventions
Lucena-Antón[1] (2018)	RCT	44	3-14	Prior diagnosis of spastic CP, non-walking children GMFCS levels: IV-V, and children aged 3 to 14 years	Children treated with botulinum toxin or surgery within 6 months.	0	Hippotherapy once a week for 45 min for 12 consecutive weeks along with conventional therapy vs control group: conventional physical therapy alone.
Deutz[5] (2018)	Randomized crossover trial	73	5-16	Bilateral spastic CP, 5-16 years old, no HT and no major surgery during the preceding 12 months, no allergy to horse hair, informed consent of the parents, GMFCS II to IV, and no achillotenotomy performed during the preceding 6 months.	Profound mental retardation with absence of basal communication skills, fear of horses, botulinum toxin therapy or major surgery intended to start during the study period.	19	16-20 weeks of hippotherapy along with conventional physical therapy in the early and late treatment groups vs 16-20 weeks of conventional physical therapy alone in the early and late treatment groups.
Kwon[6] (2015)	RCT	92	4-10	Diagnosis of CP, body weight <35 kg, and age between 4 and 10 years.	Botulinum toxin injection within 6 months, having a selective dorsal rhizotomy or orthopedic surgery within 1 year, displaying severe intellectual disability, uncontrolled seizures, or displaying poor visual or hearing acuity.	1	30 min of private hippotherapy twice a week for 8 weeks (16 sessions), in addition to conventional physical therapy vs control group: 30 min twice a week of home aerobic therapy with conventional physical therapy for 8 weeks.

joint range of motion to manually evaluate the passive movements' resistance.[1] Deutz et al. and Kwon et al. both used the Gross Motor Function Measure 66 (GMFM-66) to assess the outcomes.[5,6] The GMFM-66 is a subset of the original GMFM-88 which consists of 88 items observed by a clinician from five dimensions: (A) lying and rolling; (B) sitting; (C) crawling and kneeling; (D) standing; and (E) walking, running, and jumping.[6] An increase in score for both the GMFM-66 and the MAS indicates improvement in gross motor function.

RESULTS

Lucena-Antón et al.[1] conducted a randomized control trial to evaluate the effect hippotherapy with conventional physical therapy compared to conventional physical therapy alone has on gross motor function through the measurement of hip adductor spasticity. Children between the ages of 3 and 14 with spastic cerebral palsy were chosen from a group receiving physical therapy treatment in a Rehabilitation Center for Cerebral Palsy.[1] 44 children completed all assessments and were included in the study.[1] A simple randomization by EPIDAT software was done by an independent researcher who revealed to the participants their assignments (22 participants in each group).[1] Due to the nature of the study, the participants could not be blind to their treatment group.[1] The intervention group received 45 minutes of hippotherapy once a week for 12 consecutive weeks along with twice weekly conventional physical therapy.[1] The hippotherapy consisted of bareback riding with the therapist in charge of the constant speed of the horse and positioning of the child, focusing on postural support and neutral body and pelvis alignment.[1] The control group received only the twice weekly conventional therapy.[1]

All participants completed the intervention and measurements.[1] No adverse effects were reported.[1] Hip adductor spasticity was measured using the Modified Ashworth Scale (MAS) by

the same blinded examiner at the same time (first one week prior to the intervention and again one week after the intervention concluded).[1] A paired t-test was performed to measure the difference between baseline and post-therapy scores.[1] A t-test for independent samples was used to test the differences between each group.[1] The mean MAS score of the left adductors changed -0.05 in the control group and -0.27 from baseline in the intervention group.[1] The mean MAS score of the right adductors changed -0.09 in the control group and -0.45 from baseline in the intervention group.[1] MAS scores decreased in both groups, but mean changes in the intervention group were significantly higher than the control group ($p<0.05$).[1] A summary of the resultant values from this study are shown in Table 2 below.

Table 2. Changes in MAS Score[1]

	Control		Treatment		Between groups
	Mean change from baseline	Paired t test p-value	Mean change from baseline	Paired t test p-value	Independent t test p-value
Left adductors	-0.05	0.329	-0.27	0.011	0.040
Right adductors	-0.09	0.162	-0.45	0.009	0.047

Deutz et al. conducted a randomized, open-label, 2 x 2 (two periods, two treatments) crossover trial investigating the effects of hippotherapy on gross motor function in children between the ages of 5 and 16 with bilateral spastic cerebral palsy.[5] Two intervention periods of 16 to 20 weeks of once to twice weekly hippotherapy in addition to their usual conventional physical therapy were separated between a washout period of 16 weeks.[5] Seventy-three children were randomized to an early (n=35) or a late (n=38) treatment group.[5] Early treatment phase (ETP): Members of the early treatment group (ETG) received 16 to 32 units of hippotherapy along with their conventional physical therapy, at the same time the late treatment group (LTG)

members received only their conventional physical therapy.[5] This was followed by a 16 week washout period where all participants received their baseline physical therapy alone.[5] Late treatment phase (LTP): LTG then received 16 to 32 units of hippotherapy along with their conventional physical therapy while the ETG received their conventional physical therapy alone.[5] A clinical investigation including GMFM-66 assessments were made prior to the ETG intervention (E1), as well as follow-up clinical investigations after the ETG intervention (E2), after the 16 week washout period (E3), and again after the LTG intervention (E4).[5] An additional 8 weeks of observation of both groups was done followed by a final clinical investigation (E5).[5] Due to the nature of the study, blinding of the participants was not possible, but the physical therapists performing the GMFM-66 assessment were blind to the status of the children.[5]

There were 11 drop outs in the ETG and 8 in the LTG.[5] During hippotherapy, a child fell from a horse resulting in a humerus fracture, but no further adverse effects were noted.[5] The statistical data were presented as the mean change from baseline between no hippotherapy and hippotherapy, standard deviation, and p-value.[5] The mean between no hippotherapy and hippotherapy intervention for the ETG was +2.99, and for the LTG was +1.60.[5] A significant improvement during hippotherapy with regard to GMFM dimension E (ability to walk, run and jump) was found (p-value<0.05).[5] A summary of the resultant values are shown in Table 3 below.

Table 3. Changes in GMFM-66 Score in Regards to Dimension E[5]

Group	Period	Mean	SD	Mean b/t no HT and HT	p-value (direct treatment effect)
ETG	HT (hippotherapy)	2.81	7.18	+2.99	0.0268
	No HT	-0.18	3.45		
LTG	No HT	-0.53	5.49	+1.60	
	HT	1.07	3.05		

Kwon et al. conducted a trial of participants consisting of 92 children with cerebral palsy between the ages of 4 and 10 with variable levels of gross motor functioning.[6] An independent statistician performed the randomization of group placement using a computer-generated random blocks of 2 or 4.[6] One child in the hippotherapy intervention group dropped out so there were 45 children in the intervention group and 46 in the control group for the final analysis.[6] Children in the hippotherapy intervention received 30 minutes of private hippotherapy twice a week for 8 weeks along with their conventional physical therapy.[6] Children in the control group received 30 minutes of home-based aerobic exercise (walking or cycling) twice a week for 8 weeks along with their conventional physical therapy.[6] The primary outcome measured was the GMFM-88 that was administered before and after the 8 week trial by the same blind examiner.[6] GMFM-66 scores were calculated from the GMFM-88 using the Gross Motor Ability Estimator.[6]

Data were analyzed using paired t-tests to compare changes from baseline to post intervention between groups.[6] Changes in outcome measures between groups were assessed using independent t-tests.[6] GMFM-66 scores increased significantly in the hippotherapy group ($p<0.05$).[6] Though, no significant change was seen in the control group from baseline ($p>0.05$).[6] Changes in the GMFM-66 scores significantly differed between the hippotherapy and control groups ($p<0.05$).[6] The hippotherapy intervention group had a mean change from baseline of +2.7.[6] The results are summarized in Table 4 below.

Table 4. Changes in GMFM Between Hippotherapy and Control Groups[6]

	Hippotherapy Intervention		Control Group		P-value for difference b/t groups
	Mean change from baseline	p-value	Mean change from baseline	p-value	<0.01
GMFM-66	+2.7	<0.01	+0.4	0.26	

DISCUSSION

For many children with cerebral palsy, physical therapy is a long term and extensive part of their treatment plan. Hippotherapy is a stimulating and interactive form of physical therapy for children with cerebral palsy. Hippotherapy provides more than just physical benefits for children with cerebral palsy, though. There are psychological benefits such as increased confidence, independence, and sportsmanship.[7] A child with cerebral palsy, who may not have the motor skills and coordination to participate in most sports, can experience sitting up high upon a horse's back while it trots and runs; a feeling they may have never gotten the chance to experience themselves. The child also has the chance to build relationships with the trainer, the horse, and possibly other children. The child learns how to interact with the horse or pony and even may learn the horse's unique personality. The child learns to communicate with the horse and becomes emotionally connected.

There are barriers to hippotherapy treatment. Horses are large animals that require a great deal of care and space, preventing hippotherapy from being widely accessible. Also, the horses need to be properly trained in order to allow these young children to ride them. Hippotherapy is considered a form of physical, occupational, and speech therapy in which the therapist directs the horse's movements, providing motor and sensory input to the rider. Hippotherapy costs around $80-$115 per session. Some insurance companies will cover hippotherapy when it is prescribed by a provider, but many will not. For example, Aetna, the third largest health insurance company in 2021, still considers hippotherapy experimental and investigational because there is insufficient scientific data in the peer reviewed medical literature to support the effectiveness of hippotherapy in individuals with cerebral palsy, as well as numerous other disorders.[8]

All three studies found significant improvement in gross motor function after hippotherapy intervention, with a substantial mean change from baseline with statistically significant p-values. All three studies did have limitations. The participants could not be blinded to their treatment group which could allow for either conscious or unconscious bias by the child during their assessment by the blinded examiner. All three studies showed the short term effects of hippotherapy, and Deutz et al. assessed the effects 8 weeks after the intervention concluded, but none studied the long term effects. In Deutz et al., the 16 week washout period in the ETG may have been sufficient time to lose some of the benefits of hippotherapy such as strength, but other skills such as muscle learning, communication and confidence may persist. This could interfere with the validity of the data when comparing the ETG to the LTG control periods.

Hippotherapy is considered an adjunct therapy so all three studies had the children participate in their conventional physical therapy along with hippotherapy. Therefore, these studies could not evaluate the sole effect of hippotherapy on motor function because it did not control for the participants' other therapeutic activities. Therapists did not completely supervise conventional physical therapy or aerobic exercises performed by the control group. Furthermore, in Lucena-Anton, the intervention group received three weekly sessions while the control group only received two sessions per week. There was no attempt to replace the additional equine-based physical therapy session each week that the intervention group received, making it again difficult to determine if the effect is solely due to hippotherapy or the additional session each week.

There was an appropriately large sample size in the studies conducted by Lucena-Anton et al. and Kwon et al. Although, in the study conducted by Deutz et al., there was a 29% drop-out rate, which brought the group size for each treatment below 30, making it difficult to generalize

those results to all children with CP. Overall though, the inclusion criteria was an adequate representation of children with CP and could be generalized to those who would be appropriate candidates for hippotherapy. Lucena-Antón et al. only included non-walking children with CP which prevents the statistics from being applied generally to all children with CP.

CONCLUSION

The evidence found in this systematic review shows that hippotherapy is effective in improving gross motor function in children with cerebral palsy. Lucena-Antón et al., Deutz et al., and Kwon et al., all found statistically significant improvement in gross motor function in the intervention group compared to the control group. Improved gross motor function can allow for children with cerebral palsy to become more independent, especially through greater gait stability and control of movements.

While two of the three studies specifically included kids with spastic cerebral palsy, future studies could be done focusing on the effect of hippotherapy on gross motor function in children with different types of cerebral palsy, such as dyskinetic or ataxic. In addition, there is a fairly large age gap in these studies, ranging from toddlers with immature and actively developing motor skills to pubescent adolescents in their early teens. Future studies could be done to study the possible benefit of starting hippotherapy in early childhood versus at school age or adolescence.

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