

Effects of Hippotherapy on the Sitting Balance of Children with Cerebral Palsy: a Randomized Control Trial

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Abstract. [Purpose] This study aimed to verify the effect of hippotherapy on the sitting balance of children with severe cerebral palsy (CP) by comparing hippotherapy, physical therapy, and a control. [Subjects] In this study, 45 children with CP were randomly divided into the hippotherapy group (HTG, n = 15), physical therapy group (PTG, n = 15), and control group (CON, n = 15). [Methods] Two expert physical therapists provided the HTG and PTG with traditional physical therapy comprising strengthening and stretching exercises in 30-minute sessions, semi-weekly, for 8 weeks. Hippotherapy was provided semi-weekly only to the HTG for 8 weeks at 30 minutes per session. The CON group received no treatment. Before and after the 8 weeks of intervention, a sitting balance test was performed, and the results were analyzed. [Results] Sway pathway and velocity significantly decreased in HTG compared to PTG and CON. Left/right pathway, total pathway, left/right velocity, and total velocity were significantly reduced in PTG compared to that in the CON. [Conclusion] Hippotherapy with traditional physical therapy improved the sitting balance of children with severe CP, who could not walk independently more than traditional physical therapy alone.

Key words: Hippotherapy, Physical therapy, Sitting balance

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INTRODUCTION

Sitting balance is an important functional factor for performing activities of daily living. It involves muscles that control and give support to the trunk and has been reported in the literature dynamic stabilization, motor control, and vertebral neutralization^{1, 2)}. Clinically, sitting balance is managed by an interaction between the global muscle system and the local muscle system: global muscles control the movement of the trunk, whereas local muscles assist and stabilize the global muscles. For this interaction, strength and endurance of the muscles around the trunk are needed³⁾.

Children with cerebral palsy (CP) have impairments that interfere with their motor function, physical activity, and social participation. Neuromuscular and musculoskeletal impairments include spasticity, poor balance, loss of selective motor control, and weakness⁴⁾. Therefore, the focus of physical therapy for children with CP is on facilitation of functional independence in activities of daily living. Various therapeutic approaches are used to achieve the best functional condition considering the degree and types of impairments, motor abilities, psychological states, and other factors⁵⁾.

Hippotherapy is a rehabilitation technique in which a therapist uses the characteristic movements of a horse to

increase neuromuscular function in patients. This therapeutic method has been used mainly for children with CP⁶⁾. In hippotherapy, the rhythmic and repetitive movements of a horse provide sensory input and stimulate the upper motor neurons. The pelvic movement of a horse during walking is very similar to that of humans⁷⁾. Moreover, during hippotherapy, the body heat from the horse improves blood circulation, reduces abnormal muscle tone, and relaxes spastic muscles in CP patients⁸⁾. Physical therapists are now recognizing the various therapeutic effects of hippotherapy.

Recently, studies have been performed to verify the effects of hippotherapy in children with CP. They report increased gross motor function score, and improved postural control, balance, and gait in these children^{9–11)}. Previous studies have shown how the characteristics of horse-riding exercises affect the standing posture of children with mild CP. However, although the types of CP are diverse, including hemiplegia and diplegia, children who were studied were treated are not classified according to these CP types. Especially, studies of the effect of hippotherapy on sitting balance of children with severe CP, who have difficulty with performance of independent gait and in maintaining a sitting position, are very scarce. In previous studies, it was not clear whether the intervention effects were also receiving from physical therapy or hippotherapy, because the subjects were mostly

Table 1. Demographic characteristics

Group	Gender (male/female)	Type (Di/Hemi)	Age (year)	Height (cm)	Weight (kg)
HTG (N=14)	7/7	5/9	8.2 ± 1.1	129.5 ± 6.7	30.11 ± 7.2
PTG (N=15)	8/7	5/10	8.2 ± 1.2	130.8 ± 9.3	28.15 ± 4.3
CON (N=14)	7/7	5/9	7.8 ± 1.5	127.2 ± 5.5	29.22 ± 5.9

Note. All variables are mean ± standard deviation. Di: diplegic. Hemi: hemiplegic. HTG: hippotherapy group. PTG: physical therapy group. CON: control group.

children with mild CP who were physical therapy. Hence, the purpose of this study was to verify the effect of hippo-therapy on the sitting balance of children with severe CP by comparing 3 therapy groups: a hippotherapy group (HTG), which received both hippotherapy and physical therapy; a physical therapy group (PTG), which received only physical therapy; and a control group (CON), which received no intervention.

SUBJECTS AND METHODS

This study included 45 children with CP and was performed by the K equestrian team and staff from S hospital in Korea in 2011. The criteria for subject selection were as follows: independent gait ability of less than 10 minute; no horse riding-related experience in the previous 2 years; no internal, or neurological surgery in the previous 2 months; and no specific medical problems, including psychological problems. Parents of all the children included in this study were given a complete explanation of the study and were asked to voluntarily sign the participation consent forms before the experiment. The 3 groups (HTG, PTG, and CON) were randomized for hemiplegic and diplegic CP using a table of random sampling numbers. A pretest was performed after obtaining information on physical and medical conditions. Two expert physical therapists provided the HTG and PTG with traditional physical therapy comprising strengthening and stretching exercises in 30-minute sessions, semi-weekly for 8 weeks. For the single-blind analysis, each group was segregated from the other. One group received treatment in the morning, and the other group received treatment in the afternoon; members of both groups were forbidden to talk about the treatment. Hippotherapy was provided only for the HTG. In hippotherapy a leader pulled the reins of a horse at the front and two sidewalkers held the legs of the children to prevent them falling. Hippotherapy consists of sitting and standing in the saddle, manipulating objects (bar, ball, ring and toy) and maintaining the posture while the horse moves. CON received no treatment. After 8 weeks of intervention, a posttest was performed, and the results were analyzed. One child each in HTG and CON withdrew from the experiment. The final number of children who participated in the posttest was 14 in HTG, 15 in PTG, and 14 in CON. The demographic characteristics of each group are shown in Table 1.

A force plate (PDM Multifunction Force Measuring Plate; Zebris, Germany, 2004) placed on a wood box, was used to measure sitting balance. All subjects sat on the force plate with their arms relaxed on each side. To minimize

errors in the post-test, the center of the force plate was marked to indicate where the subjects should position the center of their hips while sitting. When seated, the subjects were asked to look at a 10-cm diameter circle placed 1 m ahead. The subjects sat with their eyes open, and the center of upper body weight was traced for 30 seconds 3 times. Rests were taken to relieve fatigue, and an assistant was on standby near the subjects during the tests to ensure safety. The pathway and velocity of the center of pressure (COP) were obtained using the formula. For each subject, the mean of 3 test results was used in the analysis.

SPSS ver. 12.0 was used to calculate averages and standard deviations. Descriptive statistics were used to analyze the general characteristics of the subjects, and the significance of the difference in the sitting balance of each group between before and after the treatment was tested using the paired *t*-test. The significance of the difference in the sitting balance was tested among the groups using 1-way ANOVA, and a post hoc test was performed using the Bonferroni correction. For all data, statistical significance was accepted at values of $p < 0.05$.

RESULTS

The changes in the center of pressure pathway and velocity before and after the therapy are shown in Table 2. No differences were observed in the pathway and velocity of the center of the upper body weight between groups before the therapy. After the therapy, all variables showed statistically significant differences pathway and velocity between groups ($p < 0.05$). The results of the post hoc test show that pathway and velocity significantly decreased in the HTG ($p < 0.05$) compared to the PTG and CON. The PTG showed statistically significant differences in left/right pathway, total pathway, left/right velocity, and total velocity compared to CON ($p < 0.05$). Within-group comparisons before and after the therapy showed that in the HTG, all variables significantly decreased after the therapy ($p < 0.05$); the PTG showed significant decreases in left/right pathway and velocity ($p < 0.05$); and the CON showed no difference.

DISCUSSION

This study aimed to verify the effect of hippotherapy on the improvement of sitting balance of children with CP. The study was a randomized control trial with a single-blind design.

Children with CP are unable to perform activities of daily

Table 2. Comparison of COP pathway and velocity in each group

Item	Direction	Pre			Post		
		HTG	PTG	CON	HTG	PTG	CON
Pathway (cm)	Lt/Rt	49.1 ± 30.3	56.8 ± 21.6	59.1 ± 27.0	21.3 ± 9.2	55.9 ± 23.1*	88.5 ± 52.1†‡
	Ant/Post	112.4 ± 56.2	93.4 ± 40.0	115.3 ± 51.3	48.3 ± 13.0	82.9 ± 22.4*	104.9 ± 47.2†
	Total	132.7 ± 69.1	120.8 ± 43.5	141.6 ± 60.6	56.4 ± 16.5	110.1 ± 34.1*	158.6 ± 71.1†‡
Velocity (cm/sec)	Lt/Rt	2.0 ± 1.2	2.3 ± 0.8	2.3 ± 1.0	0.8 ± 0.3	2.2 ± 0.9*	3.5 ± 2.0†‡
	Ant/Post	4.6 ± 2.3	3.7 ± 1.5	4.6 ± 2.0	1.9 ± 0.5	3.3 ± 0.9*	4.2 ± 1.9†
	Total	5.4 ± 2.8	4.9 ± 1.7	5.7 ± 2.4	2.2 ± 0.6	4.4 ± 1.3*	6.4 ± 2.8†‡

Note. All variables are mean ± standard division. * significant difference between HT and PT ($p < 0.05$). † significant difference between HT and CON ($p < 0.05$). ‡ significant difference between PT and CON ($p < 0.05$). sec: second. Lt: left. Rt: right. Ant: anterior. Post: posterior. HTG: hippotherapy group. PTG: physical therapy group. CON: control group

living because of proprioception loss and weakness, which affect their balance. They show asymmetric weight bearing and increased postural sway, which are the main causes of their reduced balance ability⁹). The effects of hippotherapy on the balance of children with CP have been verified through various experiments involving physical therapy. However, previous studies used different testing methods such as scoring, video monitoring, and electromyograph and force plate measurements to measure balance¹⁰). We chose the force plate method to measure balance because this method was used in the study with the largest number of subjects among previous studies¹²). Sample size is important for the reliability of the research; however, most previous studies have been limited by small sample size because of the difficulty of recruiting participants due to the characteristics of CP patients.

Our results show that the center of pressure pathway and velocity on the force plate decreased in the HTG ($p < 0.05$) compared to PTG and CON, indicating that the HTG had the highest increase in sitting balance. The HTG also showed decreased center of pressure pathway and velocity when compared with the PTG ($p < 0.05$), similar to the results of previous studies^{13–15}). Therefore, hippotherapy in addition to traditional physical therapy, as compared to traditional physical therapy alone, increases the sitting balance of children with severe CP, who cannot walk with independent gait.

Most previous studies have concluded that hippotherapy has positive effects on balance¹⁰). However, these studies had some limitations, including relatively small sample size of children with CP in the intervention group as well as different types of CP (hemiplegia, diplegia, and tetraplegia) subjects. Moreover, rehabilitation programs other than hippotherapy were not controlled. Therefore, in our study, to overcome the limitations of these previous studies, the subjects were randomized according to CP type to reach an appropriate sample size. The results of our study show that compared to the CON, the PTG had decreased total center of pathway and velocity and improved sitting balance ($p < 0.05$). These results are attributable to the effect of the strength training that was part of the physical therapy program in this study.

Generally, improvement in balance is achieved by a combination of factors, including strength, endurance, and body alignment. Thus, to improve balance, activation and coordination training of various muscles are needed rather than an independent training for each individual muscle¹⁶). Various approaches exist for the management of children with CP, including neurodevelopmental treatment (classified as a neurophysiological therapeutic approach) and the Vojta, Bobath, and Rood methods. Hippotherapy is now being used often as an alternative to these therapeutic approaches for improving the balance of children with CP; however, it was unclear whether hippotherapy is was beneficial for severe CP cases. A limitation of our study is that it is difficult to know whether the served improvements were the result of hippotherapy itself or some other treatment. Nevertheless, our study verified that hippotherapy is beneficial for children with severe CP. Further studies are needed to elucidate the effectiveness of hippotherapy for various types of CP. Few studies have been performed on the effects of hippotherapy in adults with CP; thus, detailed and diverse investigations should be performed in the future.

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