ABSTRACT

The Effect of Hippotherapy on Balance Ability in Subjects with Balance Disorders

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Hippotherapy is a type of therapy that utilizes the motion of a horse to facilitate the stimulation and stretching of muscles in people with disabilities in order to increase strength, balance ability and coordination. Though hippotherapy facilitators, patients and their parents claim that this therapy is effective, there are few studies that offer evidence to this claim. Previous studies have utilized subjective evaluations done by trained testers to evaluate balance improvements. This thesis seeks to find quantitative evidence to support the effectiveness of hippotherapy by evaluating the balance ability of subjects throughout a treatment regimen. We will use a force plate and corresponding computer program to record and analyze patient's balance before, during and after hippotherapy treatment.

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THE EFFECT OF HIPPOTHERAPY ON BALANCE ABILITY IN SUBJECTS WITH BALANCE DISORDERS

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By

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CHAPTER ONE

Introduction

Background

There are a number of disabilities that affect the lives of many children. Down syndrome is a genetic disorder that is caused by a mutation of the 21st chromosome. It is associated with a low IQ, heart defects, low muscle tone, and obesity. Autism is a social disorder that affects the way a child communicates and interacts with others. It appears in a range of severity from mild social awkwardness to severe nonverbal and nonresponsive behavior. Cerebral palsy is a disorder caused by impairment to the cerebrum during pregnancy, birth, or before the child is three years old. It has a range of symptoms including tensed or weakened muscles, mental impairment, and speech disorders.

A certain group of symptoms is common in many of these disorders: impaired balance. A disruption in balance can have severe consequences for children. Impaired balance can force children to exert more energy in completing a task than typical children (McGibbon, Andrade, Widener & Cintas, 1998;Liao,Jeny, Lai, Cheng& Hu 1997). It can impair a child's ability to participate in activities such as running and playing. It can result in decreased trunk control, leading to a lowered ability to stay upright as the child cannot react to changes in equilibrium (MacPhail, Edwards, Golding, Miller, Mosier &Zwiers, 1998). These limitations can lead to social isolation. Studies also have shown that impaired balance may lead to emotional stress on the child(Balaban& Thayer, 2001).

There are various types of therapies available to treat balance impairments. These therapies typically involve a therapist leading a patient through certain exercises and

stretches. One form of therapy, hippotherapy, uses a horse's motion as a tool to accomplish the tasks of other therapies. Children are instructed to reach for objects and move in certain ways while on horseback. These motions are similar to regular therapy, simply performed on horseback. However, there is reported benefit in simply riding. The mechanism for this is being studied but is not completely understood. It may be that the motion of the horse forces participants to move in ways they are not used to. The changing plane of the horse's back may also force the rider to react to changes in orientation helping them learn to control their balance.

Previous Studies

Balance Studies

It is important to study the effectiveness of therapy for balance in order to help alleviate the aforementioned symptoms. Most research studies evaluating the effectiveness of balance treating therapies, including hippotherapy, are typically based on somewhat subjective tests.

The Berg Balance Scale or BBS is a commonly used and accepted test to evaluate balance (Lemay & Nadeau, 2010). It consists of 14 tasks that are given a score of 0-4 based on the participant's ability to perform that task. The tasks increase in difficulty as the test progresses. A trained evaluator observes the child performing the tasks and assigns a corresponding score. The BBS was used in a 2005 Swedish study that evaluated the effectiveness of hippotherapy on a participant pool with Multiple (Hammer, Nilsagård, Forsberg, Pepa, Skargren & Öberg, 2005). The research found that BBS scores improved over the 10 week hippotherapy treatment.

Other commonly used tests include the Gross Motor Function Measure (GMFM)and the Pediatric Evaluation of Disability Inventory (PEDI). These tests assess the overall gross motor function of participants based on their performances in particular tasks as judged by a trained tester. The GMFM looks only at the physical abilities of a participant while the PEDI looks at both the social and physical abilities of participants. These tests do not test balance directly, but have dimensions that are affected by balance such as walking and standing. Some studies have shown that hippotherapy can cause improvements in certain dimensions of these tests (Sterba, Rogers, France &Vikes, 2002; Casady& Nichols-Larsen, 2004; McGibbon, Andrade, Widener & Cintas, 1998), but some tests were inconclusive (Hamill, Washington & White, 2007).

Computer Based Evaluations

There have also been objective, computer-based studies conducted to evaluate the effectiveness of balance-treating therapies. The NeuroCom Balance Master series is a set of force platforms, computers and software systems that can provide measures of balance. Each model in the series utilizes slightly different test protocols, but all track the movement of a participant's center of gravity (COG) as the participant stands on the force platform. The computer analyzes the motion of the center of gravity and assigns a score to the participant's balance ability based on the participant's control. This system was utilized in a 2009 study evaluating the effectiveness of senior jazz classes on the balance of women over 50. Twelve women were tested at regular intervals

Figure 1.1 NeuroCom Basic Balance Master, one of NeuroCom's available force platforms

using the Sensory Organization Test (SOT).In this test, the participant stands on the force platform in six different conditions: eyes open on a flat surface, eyes closed on a flat surface, eyes open with the visual field skewed, eyes open with the surface tilted, eyes closed with the surface tilted and eyes open with both the surface and visual field tilted. After 15 weeks, significant improvements were seen in the ladies' ability to balance even when their visual field was skewed and when their standing surface tilted (Wallmann, Gillis, Alpert & Miller, 2009).

Very few studies have been done that use objective measures to test the effectiveness of hippotherapy on balance. In a Portuguese study, a population of elderly people participated in an 8 week regimen of hippotherapy where therapy was administered twice a week. An AMTI AccuSway Plus platform was utilized which tracked the motion of the COG. The participants' balance was assessed twice, once before the regimen began and once after the participants had completed all 8 weeks of therapy. No significant results were reported(Araujo, Silva, Costa, Pereira & Safons, 2011).

Purpose

The purpose of the present study was to objectively assess whether hippotherapy is effective at improving balance in children with neuromuscular disorders by using the NeuroCom Basic Balance Master to evaluate balance before, midway and after a 12 week program of hippotherapy.

CHAPTER TWO

Methods

Overview

This study included 17 participants of various ages and disabilities. Participants attended weekly hippotherapy sessions for twelve weeks with individualized therapies designed by licensed therapists at the Ride on Center for Kids (R.O.C.K.). On the first, sixth and final hippotherapy sessions, the participants' balance was assessed using the NeuroCom Basic Balance Master force platform. The test was performed before and after the participant rode on each of these days, giving a total of 6 tests. Each test had 4 sections so that each participant could have a total of 24 scores. However, due to time constraints and abilities of the participants, many were not able to complete all sections.

Testing Site

Testing and therapy was administered at R.O.C.K. in Georgetown, TX. The testing was overseen by Nancy Krenek, Therapy Director and Founder of the center. Testing was conducted as well by Jennifer Howicz, Physical Therapy Assistant and Certified American Hippotherapy Association Instructor, and Judy Moore, Physical Therapist, Professional Association of Therapeutic Horsemanship Intl. Registered Instructor and Certified American Hippotherapy Association Instructor.

Participant Pool

Participants were selected from the participant pool at the R.O.C.K.. New participants at the center filled out a detailed form indicating their abilities and medical

history. Participants beginning therapy in the fall of 2011 were evaluated through these questionnaires and screened to determine if hippotherapy was an appropriate treatment option. Horses and tack were chosen based on the needs and goals of the patient at the discretion of the therapist. From this pool, participants in our study were selected because they had some degree of balance impairment. Twenty-one participants were initially selected but four were removed due to inability to complete the test. The goal for the participants was to improve ability at either standing or sitting.

Before testing began, IRB approval was obtained through Baylor University. Participants that were selected for the study had the testing procedure explained to them when they arrived for their initial riding date. Participants and their parents were given time to read the testing procedure and to sign consent forms.

Evaluations

Balance Master Measures

The Balance Master is an 18" by 18" by 2" force platform. The system is connected to a computer into which the participant's height and age is entered. Using this data, the computer is able to calculate the participant's center of gravity and track its movements as the patient stands on the platform in various conditions.

The Balance Master calculated the "Center of Gravity Sway Velocity" or "COG" Sway Velocity. This measurement is a ratio of the distance moved by the center of gravity (in degrees) compared to the time of the trial. A lower score indicates less sway and a greater control of balance while a higher score indicates more sway and less control. A maximum score of 6 can be earned when the patient falls during the trial.

The Balance Master was used to administer the Modified Clinical Test of Sensory Interaction on Balance or mCTSIB. In this test, a participant's balance was evaluated on the force platform in four different conditions: eyes either open or closed and standing either directly on the platform or on a 3" foam block on top of the platform. For each condition, the participant stood on the platform for 3 ten-second intervals and was given a score for each. The three scores were then averaged and displayed as the score for that condition. The participant proceeded through all four conditions in this way. A fifth composite score was then generated, averaging the four other scores and weighting them based on the difficulty of each condition. The composite score was only calculated if all conditions are completed by the participant.

Figure 2.1 Set-up of evaluation area with subject preparing for testing

Evaluation Protocol

The evaluation procedure consisted of the following steps. The participant was taken into a room where the platform was set up facing a wall. Partitions were arranged on either side of the platform to minimize distractions to the participant. A staff member stood close by to spot the participant if they began to lose balance. Participants were instructed to sit or stand on the platform based on their ability. Standing participants were told the exact position for their feet as determined by the Balance Master protocol. Sitting patients were

Figure 2.2 Proper placement of feet on Balance Master

positioned on a wooden stool that was placed on top of the platform. Patients were then instructed to be as still as possible.

Figure 2.3 Stool utilized by subjects that were not able to stand

The evaluator instructed the participant to begin by saying "go," then allowed all three tests for that condition to run sequentially, essentially creating one 30 second test. Testers gave encouragement and instructed the participants to remain still as the test was in progress. Once the 30 seconds had passed, the participant was told to relax and was given a moment to rest before continuing with the next condition. The conditions were completed in the following order; eyes open with the firm surface, eyes closed with the firm surface, eyes open on the foam, eyes closed on the foam. Falls and other anomalies were recorded in the computer and a notebook.

Participants selected for the study came to the R.O.C.K. for their first therapy session and were evaluated before and after they rode the horse. This is considered week 1 and referred to as "First test". Participants then attended hippotherapy sessions once a week for the next 12 weeks. Sessions typically lasted between 20 and 40 minutes. Evaluations were done again at week 6 (middle test) and week 12 (last test), before and after the participant rode the horse.

Data Analysis

Overall Progress

The scores of participants over the course of their whole treatment were compared by analyzing changes between each of the three testing dates. Participants' scores were eliminated if they did not have a score for all three dates. The participants' scores from

firm surfaces were separated from those on foam surfaces because standing on foam is much more difficult than the firm surface. We separated these two conditions as the added sway on the foam block might have obscured trends. The test scores from the first week of testing were averaged together and the standard deviations found, first for all firm scores then all foam scores. There was no differentiation made between before/after riding or eyes open/closed. This was then repeated on the scores from the middle and last dates, giving us a total of six averages. The differences were then found between individual's scores on the first and middle tests, middle and last tests, and first and last tests. These differences were averaged as well and standard deviations were found. T-test values were calculated for these as well using Microsoft Excel's TTEST function. A one-tailed, paired student's t-test was used. Then, the overall average score for each date was found, combining both firm and foam scores and all the corresponding statistical values were computed.

Before/After

Then the scores from before and after the participant rode the horse on a particular day were analyzed. There was no differentiation between testing dates or eyes open/closed but the firm and foam scores were separated. Participants' scores for which there was not both a "before" and "after" were not included in the analysis. All "before" scores from the firm surface averaged together and the corresponding standard deviation. The process was then repeated on the "before" foam data. This process was then applied to the tests from after the participants rode, giving us four averages (before/firm, before/foam, after/firm, after/foam). Finally, the firm and foam data was combined to

give two averages, one average for all “before” tests and one for all “after” tests. Corresponding standard deviations and t-test values were found.

Firm vs. Foam

The scores on the firm surface were compared to those that were conducted on the foam pad. There were no other distinctions in this analysis. However, scores were excluded if they did not have both a foam and firm score. The average of all the firm scores was calculated and compared to the average of all the foam surfaces. Standard deviations and t-test values were calculated as well.

CHAPTER THREE

Results

Twenty-one participants were originally selected. However, many of the participants were not able to complete all evaluations or even all parts of each evaluation due to the nature or severity of their disability. Some were too tired or did not have time to complete the evaluation after they had ridden the horse. Others were not able or refused to close their eyes while on the platform. This led to holes in our data. Participants 187, 194, 196, and 206 were removed because they had few scores and most were falls, making their scores skewed upward. Participants 193, 199, 204 and 207 completed the test sitting.

Overall Progress

The results of this analysis are displayed in the three tables below. In all three conditions, there was a statistically significant increase in scores between the first and middle tests, meaning that the average balance "ability" decreased. However from the middle to last tests there was generally a statistically significant decrease in scores, meaning that the balance "ability" of the participants improved. There appears to be no significant difference between the first and last tests.

Table 3.1 Average scores of participants' first, middle and last tests that were performed on a firm surface along with corresponding standard deviations and t-test values. Includes scores from both eyes open and eyes closed tests.

FIRM	First Test	Middle Test	Last Test				
average	1.3	2.0	1.6		F-M	M-L	F-L
Stdev	1.2	1.6	1.4	t-test p =	0.032	0.086	0.099

Table 3.2 Average scores of participants' first, middle and last tests that were performed on a foam surface along with corresponding standard deviations and t-test values. Includes scores from both eyes open and eyes closed tests.

FOAM	First Test	Middle Test	Last Test				
average	2.2	3.6	2.2		F-M	M-L	F-L
Stdev	1.5	1.1	1.3	t-test p =	0.008	0.018	0.491

Table 3.3 Average scores of all participants' first, middle and last tests, regardless of surface and corresponding standard deviations and t-test values. Includes scores from both eyes open and eyes closed tests.

ALL	First Test	Middle Test	Last Test				
average	1.7	2.6	1.8		F-M	M-L	F-L
Stdev	1.36	1.65	1.33	t-test p =	0.0011	0.0058	0.2253

Before/After

The results of this analysis are displayed in the three charts below. The firm test scores were statistically higher after the participants had ridden the horse. However in the foam we see a decrease in scores, though this difference is not statistically significant. There is almost no change in the combined scores.

Table 3.4 Average test scores, standard deviations and t-test value of tests done on a firm surface before and after participants rode the horse. Includes scores from both eyes open and eyes closed tests.

FIRM	Before	After
Average	2.3	2.6
Stdev	2.0	2.0
t-test p =	0.038	

*Table 3.5*Average test scores, standard deviations and t-test value of tests done on a foam surface before and after participants rode the horse. Includes scores from both eyes open and eyes closed tests.

FOAM	Before	After
average	3.6	3.3
Stdev	1.92	1.70
t-test p =	0.129	

*Table 3.6*Average test scores, standard deviations and t-test value of tests done on both surfaces before and after participants rode the horse. Includes scores from both eyes open and eyes closed tests.

ALL	Before	After
average	2.83	2.87
Stdev	2.07	1.87
t-test p =	0.409	

Firm/Foam

The following results were found when comparing the firm surface to the foam. The scores performed on foam were significantly higher than those performed on a firm surface.

Table 3.7 Average test scores from firm and foam surfaces along with corresponding standard deviations and t-test values. Includes scores from tests performed with eyes opened and closed as well as before and after riding.

	Firm	Foam
Average	1.8	3.1
Stdev	1.5	1.9
t-test p =	0.000000107	

CHAPTER FOUR

Discussion

The aim of this study was to determine quantitatively if hippotherapy improved balance ability in people with balance impairments.

Analysis of Results

Overall progress

The score generally increased from the first test to middle test and decreased from the middle test to the last test. The t-test values accompanying these calculations indicate that they are or are nearly statistically significant. This was not expected. One possible explanation is that the participants spend the first few weeks of therapy becoming acquainted with the new environment and experiences. Unfamiliarity can cause tension which would cause the participant to be stiff during testing. However as the participants become familiar with the testing center and test protocol, they may begin to loosen up, leading to higher sway scores as we observed between the first and middle tests. Eventually, the participants may begin to build muscles and posture that actually control their balance, leading to the decrease in scores which we observed from the middle test to the last test.

Though we do not know exactly why this occurs, we can say there were significant changes brought about in these participants' balance by participating in this study. Therefore hippotherapy does seem affect balance, but further tests need to be conducted to quantitatively verify whether this effect is a net positive or negative effect overall.

Before &After

We found that there was a statistically significant increase in balance sway after a hippotherapy session when the patient is on a firm surface. This could be due to exhaustion or fatigue from riding which the patient is not used to, leading to decreased concentration and less ability to control body motion. However, this was not found when the participant was standing on foam. This could be due to the difficulty of this condition. Participants had more difficulty standing on foam, creating a wider range of scores which makes it more difficult to see improvements and regressions in ability. This difficulty in standing on foam impacts the overall averages as well, making them more ambiguous.

Firm vs. Foam

We found that the scores of participants on the foam surface were significantly higher than those on the firm surface. This we expected as the foam pad eliminates the participants' somatosensory component of balance, forcing them to rely on their visual and vestibular cues (or only vestibular if the participant's eyes were closed). This makes it much more difficult to maintain posture, which generates greater sway higher scores.

Relation to Previous Work

This study is significant as it uses a purely objective, quantitative method to evaluate the effectiveness of hippotherapy on balance. Most studies of the effectiveness of hippotherapy on balance have utilized subjective means of evaluating participants, such as the GMFM, PEDI or BBS (Sterba, Rogers, France & Vikes, 2002; Hamill, Washington & White, 2007; Hammer, Nilsagård, Forsberg, Pepa, Skargren & Öberg, 2005). These subjective tests generate an overall picture of balance by having a trained

therapist observe the participant as he or she completes various tasks. This methodology is effective in its goals, preserves the uncertainty of the subjective element. But, the precision of the force platform allows us to observe much more subtle changes in balance without question of objectivity.

In 2011(Araujo, Silva, Costa, Pereira & Safons, 2011), a study was conducted looking at the balance control of the elderly before and after they went through an 8 week hippotherapy treatment. The therapy was administered biweekly and balance was assessed using a force platform. Testing occurred before and after the treatment period. This study was shorter than the present study and only found ambiguous results. This can be contrasted with Sterba's study (Sterba, Rogers, France &Vikes, 2002) where the participants participated in an 18 week study and were only evaluated with the GMFM at the beginning and end of the study. Sterba found that the participants' GMFM scores increased by this point. The longer study seems to have generated better results than either the present study or Araujo's study. It would appear that the period over which hippotherapy was administered may be a significant factor in its effectiveness. More tests with varying lengths of therapy should be conducted to establish optimal hippotherapy duration.

The juxtaposition of these three studies also allows us to see that the frequency of testing may be an important factor to understanding hippotherapy. The previous two studies did not conduct tests as the hippotherapy was administered, only before it began and after it was completed. Our study conducted a middle test and found that balance ability seems to first decrease and then increase as the therapy is administered. In order to

better understand what is occurring in the interim, future studies should add more testing dates, perhaps every other week during the therapy.

Hammer's study (Hammer, Nilsagård, Forsberg, Pepa, Skargren & Öberg, 2005) was a 10 week hippotherapy regimen where the participants were tested weekly with the Berg Balance Scale. Using this measure, researchers found that the balance ability of their participants improved over the 10 week period while we found no overall change. This may be due to the population of participants used in each study. Hammer's study contained participants that only had Multiple Sclerosis while our study contained a varied group of disorders. Hippotherapy could possibly be more effective in certain populations than others. Therefore while hippotherapy may help certain disabilities such as MS, it is possible that it is disadvantageous or neutral to certain other disabilities. Our inclusion of multiple disabilities in one study could cause improvements and regressions to cancel one another out, giving ambiguous results.

Limitations of study

The therapists at the R.O.C.K. interact with a wide range of disabilities. There were a limited number of patients that were beginning treatment at the time we began our study and so we also had a wide range of disabilities. This made it difficult to compare between participants or to draw conclusions about the effect of hippotherapy on a particular disability.

Though we found evidence that patients tend to decrease balance ability then regain it, it is impossible to tell at which point in treatment this switch occurs. It is also possible that there is a cyclic increase and decrease occurring during the weeks from which we have no data. The limited number of test dates makes it difficult to know

exactly what is occurring over the course of treatment and what would have happened if the study had been longer.

Suggestions for Future Studies

Future studies must be done with longer treatment and testing time. Our data suggests that participants may decrease in balance control at the beginning of studies but regain it as the study continues. Longer treatments may show whether this increase continues, levels off or reverts back.

Another consideration would be to be more selective when choosing participants for a study. Selecting participants who have disabilities that are more similar would perhaps allow for more clear results. Participants should be separated in the future based on their ability to stand versus sit only. This would give more precise results and allow for more conclusions to be drawn. Also participants could be separated based on level of disability or perhaps type of disability.

Further studies might explore having more evaluations throughout the treatment. Having more data would hopefully give us a clearer picture of how balance ability changes throughout the course of a hippotherapy treatment schedule.

Conclusions

Hippotherapy appears to have some impact on the balance ability of people with disabilities but further testing will be required in order to better understand what that effect is.

APPENDIX

The following table presents the raw data scores from all participants. Participants that were removed from the study due to inability to perform tests are not included. Blank spaces indicate that the test was not performed.

		first test					middle test					last test				
		firm		foam			firm		foam			firm		foam		
ID #		EO	EC	EO	EC	CO	EO	EC	EO	EC	CO	EO	EC	EO	EC	CO
188	before	4.4		5.5			4.1		4.4							
	after	3.6		3.7			4.9		4.6							
189	before	4.1	6.0	5.8			3.6	5.8	5.5			4.5				
	after	5.9	6.0				3.8	5.0	6.0							
190	before		2.1		6.0								3.3		6.0	
	after		2.6													
191	before			0.1	2.1	0.6										
	after															
192	before	3.2		4.9			4.5		3.8			3.1		4.8		
	after	4.6		4.4												
193	before	0.4	0.3	0.3	0.2	0.3										
	after	0.8	0.3	0.2	0.1	0.4										
195	before	1.4	1.6	5.3	4.4	3.2						2.9	2.7	4.1	3.3	3.3
	after	2.1	2.3	4.4	4.7	3.4										
197	before		2.5					1.3		2.4			1.3			
	after															
198	before	5.9					5.5									
	after	4.3					5.7									
199	before	0.8	0.7	0.9	0.9	0.8	3.1		3.3			1.8		3.4		
	after	1.1		3.2			3.7		3.7			1.5		2.2		
200	before	1.9		2.5			4.7		4.7			3.4		2.4		
	after	2.9	2.1	3.2	3.6	3.0	3.9	5.7	3.6							
201 / 208	before	0.7	0.8				0.6	0.9								
	after						1.0	1.2								
202	before	0.2	0.2	2.8		2.3	0.3	0.3	6.0	6.0	3.2	0.2	0.3	1.0	4.6	1.5
	after	0.4	0.4	1.3		2.0	0.3	0.3	3.2	6.0	2.5	0.3	0.3	1.7	4.4	1.7
203	before	0.2	0.5	0.3	0.2	0.3	0.4	0.8	0.8							
	after															
204	before	0.3	0.3	0.4	0.7	0.4	1.0	0.9	2.8	2.4	1.8	2.1	0.1	2.4	0.7	1.3
	after															
205	before	2.0					2.6					1.8	2.0			
	after															
207	before	1.4		2.8			1.3		2.5			2.0		1.0		
	after						3.0		1.9							

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