Use of Hippotherapy With a Boy After Traumatic Brain Injury: A Case Study

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Purpose: The purpose of this case report was to describe the use of hippotherapy with a boy who sustained a brain injury. **Key Points:** A 13-year-old boy, 6 months after traumatic brain injury received 12 physical therapy sessions, which included hippotherapy. Improvements were noted in balance, strength, gross motor skills, gait speed, functional mobility, and reported participation. **Summary:** Hippotherapy used with a 13-year-old boy after traumatic brain injury may have had a positive effect in the body structure, activity, and participation domains. **(Pediatr Phys Ther 2016;28:109–116)** *Key words: activities of daily living, adolescent, ambulation, community participation, hippotherapy, human, male, postural balance, traumatic brain injury*

INTRODUCTION

Hippotherapy, the medical use of equine movement, has been provided in the United States and Europe for over 40 years by physical therapists, occupational therapists, and speech-language pathologists.[1] Movement of a walking horse is used to facilitate a response from the person on the horse, and address functional goals. According to the American Hippotherapy Association, there are over 375 therapists with advanced training in this area.[2] Hippotherapy may improve posture and balance via movements transmitted from the back of a moving horse to an individual positioned on the horse's back. A close correlation has been shown between the 3-dimensional movements of a person's pelvis when sitting on the back of a walking horse and the movements of the same person during normal gait.[3,4] Additional investigation documented the identical sequence of muscle activation of the rectus abdominis, erector spinae, obliques, and gluteus medius muscles of a person walking, compared with the person sitting astride a horse.[5] These studies support the theory that equine movement may promote coordinated responses and development of trunk control, specifically related to gait.

In hippotherapy, the "rider" makes no attempt to control the horse. Instead, with each step the horse takes, the rider reacts to the 3-dimensional movement perturbation. Directed variations of the horse's speed and direction of movement provide opportunities for randomization, anticipatory, and reactive responses from the rider. Responses to balance perturbations improve in efficiency and effectiveness with practice opportunities.[6] At an average of 100 steps/min, the use of hippotherapy can allow for thousands of practice opportunities in a session.[7]

Several researchers have examined the effects of hippotherapy on children with a variety of disorders, such as cerebral palsy, Down syndrome, and balance impairments. Improvements in head/trunk postural stability and responses,[8,9] gross motor skills,[8,10] balance and functional skills,[9,11] and improved self-esteem and participation[10,12] are reported. Documented psychological effects of using a horse in therapy sessions with children include increased self-worth, decreased depression, increased self-esteem, improved quality of life, and improved learning.[13,14] In the adult population, hippotherapy has been linked to improvements in balance, activities of daily living, and quality of life in individuals with multiple sclerosis[15] and improved gait speed in men with chronic brain disorders.[16]

To our knowledge, published evidence regarding the use of hippotherapy with a child with an acute/subacute

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traumatic brain injury (TBI) is sparse. This case study describes the use of hippotherapy with "John", a 13-year-old boy, 6 months after sustaining a TBI.

CASE DESCRIPTION

John lived with his younger brother and parents and attended a public middle school. Family members described him as a boy who enjoyed the outdoors, video games, animals, and anything military. He was also described as a risk-taker and independent thinker with a lively sense of humor. John suffered an accidental brain injury, which led to impairments in his motor skills, functional mobility, cognition, and vision. He spent 6 weeks in a pediatric intensive care unit, and another 10 weeks at an inpatient rehabilitation facility, where he progressed from requiring maximal assistance of 1 to 2 people for transfers and being unable to ambulate, with cognitive function classified at Level III on the Ranchos Los Amigos Scale[17] to requiring moderate assistance of 1 for transfers and moderate assistance of 2 for gait, with cognitive function at Level V. Upon discharge to his home, John continued to receive outpatient physical therapy (PT), occupational therapy, aquatic therapy, speech/language services, and home-based education. The family reported that John started to use more sarcasm, enjoyed joking around, and his premorbid personality began to emerge.

After a few weeks of outpatient therapy, John's family reported that progress had tapered off and John's motivation for participation and compliance with any therapy activity had declined. Therapies were discontinued, except for aquatic therapy, which stopped a few weeks later. The family began to explore therapy options, which might be appealing to the John, as well as facilitate continued functional improvement. Being familiar with hippotherapy, and knowing John's enjoyment of animals and people, his family pursued hippotherapy. They believed the change in therapy setting, the opportunity for the animal connection, and the possible changes that hippotherapy might facilitate, would be beneficial to John.

Baseline Status

John's initial hippotherapy session occured 6 months after his TBI. At that time he presented with trunk and left-sided weakness, impaired static and dynamic standing balance, and poor functional mobility skills. When walking, he required a posterior wheeled walker and moderate assistance of 1 for balance and support, inconsistently used a left ankle foot orthosis, and was able to walk 60 ft. John was able to propel a wheelchair, primarily with his right leg, within his home and for distances up to 35 ft. For level distances greater than 35 ft and uneven terrain, he required assistance for wheelchair propulsion. Right ptosis and bilateral visual field cuts contributed to his balance and mobility deficits, as he would tilt his head backward to improve his field of vision. Behaviorally, he followed multiple step directions and was willing to try any activity presented. He displayed an appropriate sense of humor, but demonstrated a low tolerance for frustrating tasks. John displayed decreased insight into his balance deficits, as noted by his unsafe choices regarding mobility and his need for assistance in this area. According to his family, John required supervision for general safety outside his home, because of his impulsive behavior and possible decreased insight into his capabilities. These limitations affected John's ability to attend school, socialize with his peers and sibling, and participate in family outings/chores at his prior level.

Outcome Measures

The author (EE), a board-certified clinical specialist in the use of hippotherapy and physical therapist with over 25 years of experience working with pediatric and adult clients with neurologic deficits, completed the examination and administered all test items. The initial examination and posttesting were completed at the site of the intervention. The Pediatric Balance Scale (PBS),[18] Dynamic Gait Index (DGI),[19,20] and Gross Motor Function Measure (GMFM)[21] were selected as outcome measures because they specifically focused on the areas of John's deficits. Gait distance and self-selected gait speed[22] were measured to quantify gait and ability to walk in the community. In an attempt to measure John's feelings of self-esteem and self-perception, the Psychological General Well-Being Index was also administered.[23] Please refer to Tables 1 and 2.

Because of his motor impairments and functional limitations, the acuity of his injury, the potential for improvement, and John's motivation to participate in therapy in this novel setting, hippotherapy was recommended. Collaborative goals were generated, which focused on increasing independence in transfers and gait.

Description of Intervention

John received twelve, 45-minute PT sessions over a 13-week period. One session was cancelled because of John's illness. Each session included approximately 30 to 35 minutes of activities on the horse. The remaining 10 to 15 minutes was used for donning and doffing safety equipment, therapeutic activities for skill generalization, and communication with family members. A home exercise program was provided, focusing on sit-to-stand control/coordination, and gait speed and endurance. Please refer to Table 3 for the general treatment protocol.

An experienced horse handler led the horse, specifically trained for hippotherapy. The horse handler was verbally directed by the therapist to lead the horse in a specific manner or direction, on the basis of John's needs and therapy objectives. The therapist alternated between observing from a few feet away and walking alongside, providing cues. Trained volunteers walked along each side of John and the horse, as a safety measure and to assist as directed by the therapist. All sessions occurred in an enclosed indoor riding arena and included the use of industry standard safety procedures.[24]

TABLE 1
Outcome Measures

Outcome Measure	Description	Rationale for Selection	John's Initial Focal Area of Deficit
Pediatric Balance Scale[17]	A 14-item scale to measure static and dynamic balance; with high test-retest reliability with an ICC of 0.998.	Quantify changes in balance	Items requiring standing with a narrow base of support
Dynamic Gait Index[18,19]	An 8-item scale that quantifies gait under varying conditions; good test-retest reliability with an ICC of 0.82, with a test-retest ICC of 0.71.	Quantifies gait in a variety of functional aspects	Wheeled walker and physical assistance required at baseline; difficulty performing items with head turns
Self-Selected Gait Speed[21]	Measures self-selected gait speed, indoors on a level surface in a straight line, wheeled walker used	Quantify speed of gait to predict ability to walk in the community, and provide information regarding gait parameter of speed	Gait speed slow, dyscoordination
Gross Motor Function Measure (88) Dimensions D and E[20]	Progressively difficult tasks to assess gross motor skills; inter and intrarater ICC for Dimensions D and E of 0.90	Gross motor activities in Dimensions D and E were difficult for John	D: Items requiring balance without upper extremity support were challengingE: Activities requiring a change of speed, unilateral stance, and jumping were difficult
Psychological Well-Being Index[22]	A 22-item questionnaire about a person's self-perceptions of emotions, stress, and ability to relax over the past 2 mos. A high score of 120 reflects good quality of life and contentment	Quantify John's feelings of self-worth and self-esteem	Flat affect and sarcasm, difficult to assess self-perception

Abbreviation: ICC, intraclass correlation coefficient.

To maximize John's comfort and ability to focus on the therapy rather than a change in personnel, the same therapist, horse, horse handler, and side walkers worked with John each session. Behavioral strategies maximized safety. The behavioral approaches included rewards for compliance, timed activities, "barn rules," predictable routines, and the use of motivators for positive behavior. "Barn rules," such as no quick movements or loud voices, were safety rules that applied to all people in the barn area, and were readily accepted by John. His social needs were addressed by the use of age-appropriate conversation, and letting him have a part in the decision-making process. John appeared to enjoy his sessions; arriving early, interacting with his team, and attempting all tasks requested. During 2 sessions, he was less focused, less agreeable, and more sarcastic with his communications. To maximize the safety of all, on these days John was provided with more choices, and the movement of the horse was used as the primary therapeutic tool while he was mounted, versus extra demands of John. He participated in more unmounted horse-related activities to work toward his goals, such as brushing or feeding the horse during these 2 sessions. Four weeks into the hippotherapy sessions, the family reported that aquatic therapy services were discontinued.

Although John and his family reported satisfaction with the therapy and observed improvements in John's mobility, they elected to discontinue therapy services after 12 sessions. The family stated there were transportation issues since John's return to school, as well as a time factor, as the commute to the therapy site was 75 minutes in each direction.

Description of Outcomes

At completion of the program, John demonstrated improvements in his overall balance, functional strength, functional mobility, gross motor skills, and activity level. He had returned to school fulltime and reported increased social experiences with his brother and family, and decreased use of the wheelchair. His scores improved in all physical outcome measures. Please refer to Table 2.

Of interest, were the improvements in speech noted by his family, friends, and medical team. These included increased volume, affect and intonation, descriptive language, and decreased language-processing speed with increased response time. John also demonstrated an increased vocabulary and sense of humor.

One year after discharge, a follow-up call with his family revealed that John was walking independently with a single-point cane in the community for distances up to 150 ft. The family reported that John no longer received PT, but continued to use the ankle foot orthosis and wheeled walker at school inconsistently, to avoid fatigue. John continued to receive psychology services.

DISCUSSION

This case study describes the use of hippotherapy with a 13-year-old boy, 6 months after sustaining a TBI. Improvements are documented in the body structure/impairment domain with observed changes in functional muscular strength and static and dynamic standing balance. Positive changes in functional mobility, gross motor skills, and participation in home, school, and community activities are also described.

TABLE 2
Baseline and Posttest Status

Measure	Baseline	Baseline Comments	After 12 Sessions	1-y Phone Follow-Up
Balance				
Pediatric Balance Scale	11/56	Difficulty with items requiring a narrow base of support, timed movements; excessive ankle/hip strategies observed	39/56	Not available
Tandem stand—right leg behind	Unable	Required physical assistance at the trunk to sustain center of mass over base of support	10 s	Not available
Left single-leg stance	Unable	Required physical assistance at the trunk to sustain center of mass over base of support	6 s	Not available
Functional mobility				
Primary mobility method	Wheelchair	Required physical assistance for brake management, propulsion and navigation that was not a straight line on a level surface; propelled ~35-ft distance	Ambulation	Ambulation
Sit-to-stand transfer	25%-50% assistance required	Assistance required due to loss of balance and difficulty with forward weight shift and advancement of left leg	Independent	Independent
Ambulation level	25%-50% assistance of 1 with wheeled walker, no AFO used	Assistance required due to loss of balance during unilateral stance and for steering/placement of posterior wheeled walker; ambulation on level surfaces only	Independently with posterior wheeled walker; John had left ankle-foot orthotic device, but did not use it consistently, or in therapy sessions	Independently with single-point cane, occasional use of ankle-foot orthotic device
Ambulation distance	60 ft	Fatigue reported with increased foot drag and increased physical assistance required at 50- to 60-ft mark	>300 ft	>1000 ft
Gait speed	0.34 m/s	Self-selected, indoors, on a straight line	0.61 m/s	
Ascended/descended steps (5) with a railing	"Step-to" pattern, and 25% assistance	Pulled on railing for support, assistance for balance and placing foot on step	Reciprocal pattern and supervision	Independent, reciprocal
Dynamic Gait Index	0/24	Required wheeled walker for all	14/24	Not available
Motor skill				
Gross Motor Function Measure—D (standing)	79%	Difficulty with items requiring a narrow base of support	87%	Not available
Gross Motor Function Measure—E (walking, running, jumping)	39%	Difficulty with items requiring single-leg stance, jumping	74%	Not available
Jump in place	Unable to clear floor	Trunk/hip/knee flexion with no propulsion off the floor, minimal hand-held assistance for balance	3 jumps, minimal hand-held assistance for balance upon landing	Not available
Jump forward, left hand-held assist for balance	Unable to clear floor	Stepped forwards, minimal hand-held assistance for balance	10 inches forward, minimal hand-held assistance for balance upon landing	Not available
Strength				
Strength: sit-ups	4 in 10 s	In hook lying, feet anchored	6 in 10 s	Not available
Hip extension	4-/5 bilaterally	Jerky, uncoordinated movement	4 → 4+/5	Not available
Ankle plantar flexion	Right: 3 repetitionsLeft: unable	With upper extremity support at bar	Right: 10Left: 4	Not available
Other				
Psychological Well-Being Index	68	Quantifies perceptions of enjoyment, interest, and life satisfaction over the past month	67	Not available

Abbreviation: AFO, ankle foot orthosis.

TABLE 3
Equipment and Treatment Protocol[a]

Treatment	Duration (min)	Treatment and Progression of Treatment	Rationale for Treatment Approach
Equipment selection: saddle or pad with strap; stirrup use	Pad or saddle was used throughout the entire session; stirrup use varied within the session	Both *saddle and pad*: increase demands as per treatment protocol that follows *Stirrups:* alter base of support based on John's response and treatment goals	*Saddle*: increase pelvic/proximal lower extremity support to allow for development of trunk control, permits only activities in the forward astride position. *Pad*: more contact with horse, less pelvic/proximal lower extremity support than a saddle, allows for a variety of positions: forward astride, rear astride, quadruped Provide more support initially as needed, progressing to less as ability to sustain trunk control improves *Stirrups*: provide an increased base of support, additional distal LE support and sensory information, and a surface for LE weight-bearing activities
Don safety equipment	1-2	Don American Society for Testing and Materials/Safety Equipment Institute horseback riding approved helmet; 4-inch wide hook and loop gait belt with handles	Safety
Warm-up	2-3	John is facing forward astride on a pad or in a saddle; horse is walking forward, path is a straight line with curves	Warm-up of muscles used to sustain upright sitting position, accommodation to the 3-dimensional movement, proprioceptive information, and visual flow
Variations in equine movement	2-20	(a) Acceleration/deceleration (b) Circles of varying diameters, figure 8 patterns; begin with larger movements and progress to smaller turns (c) Add ground poles for horse to step over	Challenge postural control and increase variety of adjustments needed by John, focusing on anterior/posterior control, lateral weight shits and compensatory adjustment, strengthens core musculature
Variation in John's position		Change John's position to: (a) Sitting facing the rear (b) Quadruped position with UE weight bearing on the horse's rump, cervical alignment in neutral; progress to lifting head and looking around, lifting one UE; For both positions, horse is standing still while John assumes position, progress to horse walking, in a straight line with gentle curves	Increases proprioceptive input to UE, strengthen proximal/core muscles, provides atypical vestibular/visual information, promote midline awareness and motor planning
Active exercises	2-20	Position John with feet in safety stirrups, incorporate a, b, c (above); progress to sustaining a partial sit-to-stand or "2-point" position, with UE leaning on the base of the neck of the horse, progress to unilateral UE weight bearing, repeated sit to stand, repeated sit to stand in rhythm with horse movement; provide external cues for symmetry	Increases strength, promotes eccentric control with timing, symmetry and left/right LE weight bearing, promote LE weight-bearing control
	2-20	(f) Sitting: add trunk rotation/upper extremity elevation exercises, progress from unilateral to bilateral and sustained positions; midline crossing, ball toss/catch, visual scanning of environment	Promote upper trunk extension, limb strength and control, challenges overall muscular engagement, balance with changes in center of mass; challenge increased with visual scanning, which alters vestibular and visual information
Cool-down	2-3	John is facing forward astride on a pad or in a saddle; horse is walking forwards at 80-100 steps/min	Provide transition to complete mounted activities
Land activities	5	Standing balance activities, progressing from static to static with external perturbations, to dynamic activities; practice walking on level surface, progress to uneven terrain, varying speed	Generalization of learned or practiced skills to standing and gait

(*continues*)

TABLE 3
Equipment and Treatment Protocol[a] (*Continued*)

Treatment	Duration (min)	Treatment and Progression of Treatment	Rationale for Treatment Approach
Home exercise program	~5 to 10 min/d	• From a firm seat, sit to full stand, without UE assistance, emphasizing forward weight shift over feet and controlled movement • Sitting on a firm seat, hands clasped, bilateral UE "chopping" in diagonal motion from mid lateral calf to above head on the contralateral side, with attention to inclusion of trunk rotation/flexion/extension, following hands with the head and eyes, and controlled motion • Walking with walker for increasing distances, varying the pace	Promote coordinated use of trunk/extremity muscle combinations for transfers, sitting balance, and trunk extension, increase walking distance at a variety of speeds

Abbreviations: LE, lower extremity; UE, upper extremity.
[a]Adapted with permission from Silkwood-Sherer et al.[11]
After warm-up, progression and activities varied, depending on John's attention, fatigue, and preferences. Unless otherwise noted, the horse is moving at 80 to 100 steps/min throughout, except during position changes in and out of quadruped

John demonstrated improvements in his PBS and DGI scores, as well as his gait speed. Reported minimally detectable changes for the Berg Balance Scale, from which the PBS was developed, range from 3.3 to 6.3 for adults who have sustained a cerebral vascular accident.[25] John's change in score on the PBS exceeded this range of detectable change, with specific improvements noted on the test items requiring a narrow base of support or a weight shift.

Activities that provide mechanical perturbation of the base of support, promote the use of coordinated muscle recruitment, and increase context-related muscular strength may lead to more effective balance.[6] In adults, increased core strength through nonresistive exercise in multiple planes has been linked to improved gait parameters and Timed Up and Go scores.[26,27] Hippotherapy, by nature of its direct movement perturbations to the trunk, provides targeted nonresistive training of core muscles in a coordinated pattern mimicking human gait,[3,4] so it is logical to believe that hippotherapy may have contributed to John's ability to maintain his balance in a manner that specifically led to improved gait and transfers. In this case, improvements in strength may also be attributed to the exercises in the home exercise program.

In addition to the imparted movement perturbations, hippotherapy provides movement through space. This combination of movements promotes adaptive responses, as well as processing of visual, somatosensory, and vestibular information. It is feasible that John was able to generalize these responses to walking and balance activities. In older adults, a minimal detectable change in DGI score of 2.9 is reported.[28] John's postintervention DGI score exceeded this range. John's self-selected walking speed also increased. Improvements in gait speed and the DGI score may be linked to an increased ability to accommodate to varied movement through space.

Motor learning theory suggests that effective balance training requires opportunities for predictive strategies and reactive responses.[6] It is hypothesized that the improvements in balance observed after hippotherapy might relate to the opportunity for both anticipatory and reactive postural control.[11] Varied and specific equine movements impart this targeted and repetitive neuromuscular facilitation at a high intensity of practice with the horse stepping at a frequency of 80 to 100 steps per minute for the majority of the session. Altering John's position on the horse provided opportunities for motor planning and a variety of muscular responses. Sit-to-stand and partial stand ("2-point") activities may have promoted development of hip/ankle balance strategies. Standing and gait activities immediately after the mounted activities promoted generalization of skills.

Minimal clinically important differences have been reported for the GMFM for children with CP, on the basis of the Gross Motor Classification System (GMCS).[29] John could be described as GMCS Level III because of his need for an assistive device. John's improvements well exceed the reported minimal clinically important differences for large effect size of 2.4 for Dimension D and 3.0 for Dimension E. Improvements in jumping skills may be related to improved core strength and balance previously discussed, and exercises in the squatting position with the use of stirrups.

Hippotherapy has been linked with improved self-esteem and confidence, with reported carryover into daily life.[30] It has been proposed that this feeling of increased self-esteem may in itself promote the recovery process.[31] Improved mental health after hippotherapy, compared with traditional PT, has been documented.[32] The novel and "nontherapy" atmosphere of the barn environment, coupled with the opportunity for animal engagement, may have positively affected John's motivation for therapy, self-esteem, confidence, and subsequently his participation in nontherapy activities.

Interaction with the horse was encouraged and used advantageously by allowing John to make decisions about the therapy session as well as feed, brush, pet, and care

for the horse. For example, John would work on standing balance while holding a feed bowl for the horse. He would make the necessary postural adjustments as the horse pushed the bowl with its muzzle, providing an unexpected external perturbation. Removing equipment from the horse also provided a functional way for John to generalize his skills.

John complied with all safety rules, and initiated more conversation and interactions as the weeks passed. He did not discuss his home or school life during the sessions, and when questioned directly in regard to "how are things going?" would make a humorous comment and deflect the question. One area in which John did not demonstrate improvement was on the Psychological Well-Being Index. According to his family, at the time of the posttest, John was verbalizing more concerns regarding the accident in general and was reportedly more aware of the loss of some friendships, which may have affected his score. The family was seeking additional psychological services to address these concerns.

Hippotherapy has been linked with motor and participation improvements in a variety of neuromuscular disorders.[8-13,32-35] Although the described improvements in this case cannot be solely attributed to hippotherapy, the family reported acceleration in John's rate of improvement during the period of this intervention, even with discontinuation of aquatic therapy. Per family report, many of these gains were sustained and improved upon over the following year. The incorporation of hippotherapy may have allowed for intense practice opportunities, specifically focusing on trunk control and promoting improvement in several aspects of John's life. In addition, the novel environment and opportunity to interact with a horse may have positively affected John's behaviors, motivation, and motor outcomes. Further investigation with larger participant groups is needed to explore the effectiveness of hippotherapy with this population. John demonstrated changes 6 months after injury; the effect of this intervention on individuals with more acute injuries as well as chronic residual deficits is needed. Exploration of therapeutic dosage, with measures sensitive to specific aspects of balance, changes in postural control, gait pattern and parameters, and self-esteem/participation may better describe the use of equine movement for motor rehabilitation.

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