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Physical Therapy Management of a Patient with Severe Ataxia and Imbalance Secondary to Herpes Simplex Encephalitis

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Abstract

Background and Purpose: Herpes Simplex Encephalitis (HSE), the most common cause of sporadic viral encephalitis, causes permanent neurologic deficits and disablement in many affected individuals. To our knowledge, there have been no published studies that have examined any aspects of rehabilitation for individuals with HSE. The purpose of this case report was to investigate the effects of a physical therapist directed rehabilitation program to improve balance and gait in an individual with severe ataxia and imbalance secondary to HSE.

Case Description: A 25-year-old male with acute vestibular neuritis and diffuse cerebellitis caused by HSE presented to an inpatient rehabilitation hospital with nystagmus, motion sensitivity, trunk tremoring, and balance and coordination problems that impaired his ability to transfer, walk, and perform his daily life activities.

Intervention: The individual participated in an intensive 17 day, six day per week physical therapy program, consisting of eye-head coordination and habituation exercises, balance training, and functional task practice.

Outcomes: Outcome measures used were the Functional Independence Measure (FIM), Berg Balance Scale (BBS) and the Brief Ataxia Rating Scale (BARS). Improvements were noted in all outcome measures (pre to post); the patient progressed from a 0/56 to a 49/56 on the BBS and from an 18/30 to a 7/30 on the BARS. Improvements in sitting balance, transfers, and walking enabled the patient to return home with assistance from his parents for driving and some fine motor tasks.

Discussion: Physical therapy may improve balance and mobility for patients with cerebellar and vestibular pathologies secondary to HSE.

Keywords: Ataxia; Balance; Cerebellitis; Gait; Herpes Simplex Encephalitis; Rehabilitation; Vestibular Neuritis

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Introduction

Herpes simplex encephalitis (HSE), the most common cause of sporadic viral encephalitis, is a serious disease that can lead to death or significant morbidity [1]. Most cases of adult HSE are

caused by Herpes Simplex Virus-1 (HSV-1) [1]. The incidence of HSE is one to three per million population [1]. It occurs equally across genders, and has a bimodal age distribution with the majority of affected individuals being either below 20 or over 50 with the peak between 60 and 64 years [1]. HSE typically causes acute symptoms of fever, headaches, focal neurologic deficits, and altered mentation [2, 3]. The virus typically damages frontal and temporal lobes, but rarely it affects the cerebellum and brainstem, causing cerebellar and cranial nerve abnormalities [1-6]. Due to better diagnostic testing and earlier treatment with the antiviral drug acyclovir, more people are surviving after HSE, but many have persistent neurologic deficits especially in executive functioning, motor planning and spatial awareness [1, 2].

Rare manifestations of HSE as experienced by the individual in this case report are acute vestibular neuritis and diffuse cerebellitis [3, 5-7]. Acute vestibular neuritis, a type of unilateral vestibular nerve dysfunction, commonly causes vertigo, disequilibrium, spontaneous horizontal nystagmus, nausea, vomiting, and blurred vision [7, 8]. Vertigois constant acutely but after a few days, symptoms are often only provoked by sudden movements or by certain head positions [7, 9, 10]. Symptoms of cerebellitis depend on the affected cerebellar region. Damage to the midline cerebellar regions results in truncal instability manifested by trunk tremoring in an anterior-posterior plane and gait ataxia, while damage to the cerebellar hemispheres causes dysarthria and appendicular ataxia marked by hypotonia, decomposition of limb movements, dysmetria, and dysdiadochokinesia [3, 11]. Common oculomotor impairments caused by cerebellar dysfunction include saccadic hypermetria, impaired smooth pursuit, increased Vestibulo-Ocular Reflex (VOR) gains, impaired fixation suppression of the VOR, and jerk nystagmus [12].

This case report is the first to describe the design and implementation of a rehabilitation program for a patient with severe balance and gait problems secondary to acute vestibular neuritis and cerebellitis caused by HSE. Due to the lack of research on rehabilitation of individuals with HSE or with concomitant vestibular and cerebellar pathologies, the treatment strategies employed in this case were based on previous treatment principles for gaze instability, motion sensitivity, and ataxia by progressively challenging the individual through regular and repetitive practice of gaze stabilization and habituation exercises, complex balance and motor coordinative tasks, and gait training on a treadmill and overground with an Assistive Device (AD).The principal goal of this intervention was the reduction of balance and gait abnormalities to improve the patient's efficiency and safety with mobility. This comprehensive treatment approach may provide physical therapists with a framework for clinical decisions regarding interventions to improve gait and balance in patients with HSE or other pathologies with similar presentations.

Case Description: Patient History and Systems Review

The patient was a 25-year-old male referred to Physical Therapy (PT) with a diagnosis of HSE. The patient initially noticed a mild ear ache that progressed over 48 hours to "dizziness," nausea, and a "drunken sensation." Upon hospital admission he exhibited severe axial tremor and gait ataxia, gaze-evoked horizontal nystagmus, photophobia, and myoclonus. Magnetic Resonance Imaging (MRI) showed diffuse bilateral cerebellar enhancement. Cerebrospinal fluid analysis revealed abnormalities suggestive of HSE [1, 2, 4]. The patient was started on acyclovir (Zovirax) to suppress the HSE virus (10 mg/kg three times daily intravenously), methylprednisolone sodium succinate (Solu Medrol) to control inflammation (10 mg/kg over a period ≥30 minutes), and a scopolamine (Transderm Scop- 1.5 mg) patch for the "dizziness." He was transferred to an inpatient rehabilitation facility.

Prior to symptom onset the patient lived alone in a two floor town house apartment, with two steps to enter. He worked fulltime as an auditor and was finishing a master's degree. His parents and siblings lived nearby and were very supportive. He exercised 4-5 days a week at a gym and played football and baseball for recreation.

The physical therapist's initial evaluation of the patient was performed one day after his admission to the rehabilitation hospital and 14 days following symptom onset. The therapist

applied the framework for decision making by Schenkman et al. [13] to guide her clinical decisions regarding the patients' physical therapy management. The patient was alert and oriented, followed multi-step commands, and gave a thorough history. He stated that his biggest deficits were difficulty with balance and nausea with any type of movement. His main goal for Physical Therapy (PT) was to walk independently to allow a return to his previous lifestyle.

Based on the patient's complaints of severe disequilibrium, nausea, and motion sensitivity along with MRI results, the therapist determined that a thorough examination of the vestibular system and cerebellar function was warranted. The patient was a good candidate for a case report because his rare and complex symptomatology and severity of impairments and activity limitations made his PT management uniquely challenging.

Examination

Systems Review: Auditory testing revealed a slight decrease in hearing in his left ear. Sensation was intact to all modalities throughout his face and body. Manual muscle testing and range of motion testing showed full active and passive range of motion and normal strength. Muscle tone and deep tendon reflexes were normal in all extremities. The Babinski test was negative bilaterally.

Vestibular System Tests: The patient exhibitedspontaneous right beating horizontal nystagmus at rest, (visualized by therapist without aid of frenzel glasses and named for the fast phase of nystagmus) but reported blurred vision only with horizontal head movements >72 Hz. Eye movement testing with the head stabilized showed slowed smooth pursuit tracking and saccadic intrusions. Head thrust and VOR cancellation tests were both positive with head movement to the left. The head thrust test is a sensitive test which detects unilateral vestibular hypofunction [14]. The positive left VOR cancellation test suggested central vestibular dysfunction, possibly due to left cerebellar pathology [8, 12]. The patient was extremely motion sensitive, with head turns causing vertigo and nausea. Dix-Hallpike and roll tests were negative for benign paroxysmal positional vertigo [8].

Cerebellar Function: The patient demonstrated trunk tremoring at rest mostly in upper body areas which then involved his trunk and legs with any head and/or trunk movements or position changes. Tremoring decreased with axial pressure applied downward through his shoulders and returned to baseline level within 2 minutes after stopping movements. Limb coordination testing (i.e., finger-to-nose, heel-to-shin) revealed marked dysmetria and intention tremors with his left extremities more involved than right. Decreased cadence was noted with rapid alternating movements of all extremities. To quantitatively assess the patient's ataxia symptoms, the Brief Ataxia Rating Scale (BARS) was performed (Table 1) [15].

Table 1: Brief Ataxia Rating Scale Scores at Admission and Discharge

Task	Admission	Discharge
Gait	(8) 2-person assist; wheelchair	(3) Walking without support but with considerable staggering; difficulties in half turn
Knee-Tibia Left	(2) Lowering jerkily in the axis	(1) Lowering of heel in continuous axis, but movement is decomposed in several phases, without real jerks, or abnormally
Knee-Tibia Right	(2)	(1)
Finger to Nose Left	(3) Segmented movement in more than 2 phases and /or considerable dysmetria in reaching nose	(1) Oscillating movement of arm and/or hand without decomposition of the movement

Finger to Nose Right	(1)	(0) Normal
Dysarthria	(0) Normal	(0) Normal
Oculomotor Abnormalities	(2) Prominently slowed pursuit, saccadic intrusions, hypo/hypermetric saccade, nystagmus	(1) Slightly slowed pursuit, saccadic intrusions, hypo/hypermetric saccade, nystagmus
Total	18/30	7/30

Balance/Mobility Tests: The patient's balance and mobility was assessed using the Berg Balance Scale (BBS) and Functional Independence Measure (FIM) motor section respectively [16, 17]. Due to severe tremoring, the patient failed to complete any items on the BBS without assistance or arm use, thus scoring a 0/56 (Table 2) [16]. Initial FIM motor scores can be found in Table 3. Bed mobility was independent but labored and slow. Supine to sit transfers required moderate assistance with bilateral arm support and foot flat floor contact. Sit-to-stand transfers required maximal assistance with the therapist blocking his knees to prevent flexion due to tremoring. Standing pivot transfers required maximal assistance of two people. His gait was wide-based and staggering, with a step-to pattern using the therapists' forearms for support, and required maximal assistance of two people to ambulate safely. The patient's primary difficulties were with execution and termination of movements in sitting, standing, and walking in all environments.

Table 2: Berg Balance Scale Scores at Admission and Discharge

Task	**Admission**	**Discharge**
Sitting to standing	(0) needs moderate or maximal assist to stand	(4) able to stand without using hands
Standing unsupported	(0) unable to stand 30 seconds unassisted.	(4) able to stand safely 2 minutes
Sitting with back unsupported but feet supported	(0) needs assistance to sit	(4) able to sit safely and securely for 2 minutes
Standing to sitting	(0) needs assistance to sit	(4) sits safely with minimal use of hands
Transfers	(0) needs 2 people to assist or supervise to be safe	(4) able to transfer safely with minor use of hands
Standing unsupported with feet together	(0) needs help to attain position; holds < 15 seconds	(4) places feet together and stands safely 1 minute
Standing supported with eyes closed	(0) needs help to keep from falling	(4) able to stand for 10 seconds safely
Reaching forward with straight arm while standing`	(0) loses balance while trying/requires external support	(4) can reach forward confidently 25 cm
Pick up object from floor from a standing position	(0) unable to try/needs assist to keep from losing balance	(4) able to pick up object safely and easily
Turning to look behind over left and right shoulders while standing	(0) needs assist to keep from losing balance or falling	(4) looks behind from both sides and weight shifts well

Turn 360 degrees	(0) needs assistance while turning	(4) able to turn 360° safely in 4 seconds or less
Placing alternate foot on step or stool while standing unsupported	(0) needs assistance to keep from falling/unable to try	(2) able to complete 4 steps with supervision without assist
Standing unsupported one foot in front	(0) loses balance while stepping or standing	(2) able to take small step independently and hold 30 seconds
Standing on one leg	(0) unable to try or needs to prevent fall	(1) tries to lift leg, unable to hold 3 seconds but remains standing

Table 3: Functional Independence Measure Scores at Admission and Discharge

Task	Admission	Discharge
Rolling in bed	7	7
Supine to sit	3	7
Sitting with arm support and feet on floor	2	7
Sit to supine	4	7
Sit to stand	2	6
Transfers	1	6
Ambulation	1	6

FIM Scores: 7- independent, 6- modified independent, 5- supervision or set-up, 4- minimal assistance (patient can perform 75% or more of task), 3-moderate assistance (patient can perform 50-74% of task), 2- maximal assistance (patient can perform 25-49% of task), 1-total assistance

Evaluation, Diagnosis, Prognosis

The examination findings were consistent with vestibular system andcerebellar dysfunction which was greater on the left side. Based on these findings, the physical therapist referred the patient to a neuro-optometrist and a neuro-otolaryngologist for more extensive visual and vestibular testing respectively. The neuro-optometrist reported that the patient's visual acuity tested normal despite nystagmus. The neuro-otolaryngologist reported that the patient had a left otolith/left-sided vestibular loss and mild right sided vestibular hypofunction. Thus, the patient's impaired gaze stabilization, motion sensitivity, and postural instability were related to vestibular nerve hypofunction/loss in combination with cerebellar dysfunction caused by HSE.

The therapist's impression was that the patient's gaze instability, severe motion sensitivity, truncal ataxia, incoordination of limbs, and balance deficits were the greatest contributors to his inability to walk and perform activities of daily living. His prognosis to walk independently was good based on his young age, prior active lifestyle and good health, stable medical status, and strong motivation. Patients with HSE under 30 years of age with a higher Glasgow Coma Scale (GCS) rating (over 6) were more likely to return to a normal level of function than patients who were older than 30 with GCS scores lower than 6 [1, 4]. The patient's age of 25 and the fact that he did not lose consciousness were positive factors for his recovery. However, it was anticipated that his progress would be slowed by the severity of his truncal instability.

Intervention

To maintain the patient's motivation, provide high intensity task training that would maximize motor learning and address the patient's activity limitations, the patient was scheduled for two 45- 60 minute PT sessions daily, with one session focused on eye-head coordination and balance exercises and the other on gait training. The patient also received speech and occupational therapy twice daily as well as rehabilitation psychology 2-3 times per week. Follow-up of BARS, BBS, and FIM motor assessments were planned at completion of 3 weeks. The progression of activities over a 3 week period can be found in Table 4.

Table 4: Progression of Treatment Activities

Treatment Activity	Progression	Rationale
Phase 1	Duration: 1 day	Promote static and dynamic sitting balance
1. Gaze stabilization and habituation exercises including VOR X 1 done in supine	Moving from supine VOR X1 to sitting VOR X1, then to sitting VOR X 1 with a complex background of neutral colored, horizontal stripes of various widths. Habituation exercises in sitting and changing position with whole body movements.	To promote strategy of visual fixation to allow patient to balance and find his BOS in the absence of normal visual input. Habituation exercises of whole body to slowly begin to tolerate movement and position changes.
2. Dynamic trunk movements / habituation	Left, right and diagonal leaning with visual fixation done in sitting with feet flat on floor with wide base of support (greater than shoulder width) and bilateral arm support on mat or bed.	To promote mobility and independence within environment as well as continue allowing the body to adapt to sensory mismatch from abnormal visual input and lack of left sided vestibular input during movements.
Phase 2	Duration: 1 day	Promote sitting balance without UE use and transitional movements. This was done once the patient could sit independently without UE support
1. Dynamic Sitting without UE support	Feet flat on floor, wide base of support moving to a more narrow base of support. Starting with arms length excursion for reach and progressing to around 6 inch reach forward, diagonal and lateral and then sitting with eyes shut. Began with single arm reach and progressing to no arm support and two arm reach.	To promote body relearning COG, allow functional movements within his environment as well as adaptation to sensory information with and without visual information.
2. Supine to sit		To promote transitional movements and independence within his environment
Phase 3	Duration: 4 days	Transitional movements and gait training; initiated when patient could sit safely and independently and reach 6 inches without UE

		support and feet a narrow width apart on floor as well as transition supine to sit independently
1. Sit to stand	With moderate therapist assist progressing to stand by assist with a standard walker, weighted with 14 pounds.	To promote transitional movements and independence within his environment.
2. Static standing balance with UE support	Parallel bars using 2 arms to 1 arm support, once parallel bars were mastered with normal BOS and 1 arm support, a standard walker with 14 pound weight placed on cross bars was used	To promote body's tolerance to upright and allow weight bearing on the LE's and prepare the body for gait training. Began with a very stable AD due to the severe nature of his tremors.
3. Pre-gait activities and gait	Began in parallel bars with 2 arm support and therapist's assist for lateral weight shifts, then weight shift and slide one foot, progressing to steps forward and back, progressing with standard weighted walker for gait training	To promote transitional movement, gait training, weight shifting while maintaining COG and functional ambulation
Phase 4	Duration: 4 days	Once patient could stand with minimal assistance without UE support, this phase was initiated because it allowed dynamic activity using UE's
1. Standing balance activities	Variety of simple tasks with wide BOS such as reaching for objects or catching a foam ball progressing with feet closer together and more dynamic activities such as catching a weighted ball throwing with a chest pass.	To promote dynamic balance and reaction time with balance activities as well as eye-hand coordination. Also promotes visual tracking and fixation.
2. Gait training with AD	Began with standard weighted walker to allow patient ability to walk longer distances but be stable due to tremoring. Progressed each stage once patient was CGA with the device.	Progression to least restrictive assistive device that was safe and the patient could be independent with for ambulation. Progressed once patent was CGA so the patient could be safe and had mastered the least restrictive AD possible.
Phase 5	Duration: 5 days	Initiated once the patient could walk with therapist assist without an AD and transfer independently.
1. Balance activities without any AD or UE support, therapist CGA to SBA	Began with high level balance activities to work on functional balance in a variety of planes and on functional strength Including lunges, squats, single leg activities, step ups and progressed to timing	Working on balance reactions, hip and ankle strategies, moving farther out of the COG and balance within the areas of muscular passive insufficiency to allow safety and independence in

	and balance activities combined such as "Red Light- Green Light"	a variety of ADL's.
2. Gait training without AD and vestibular exercises	Performed gaze stabilization exercises with SBA gait training in quiet hallways and crowded hallways with and without path finding. Trial of BWSTT and standard treadmill training to allow increased speed and distance for gait.	Treadmill training was chosen to increase gait speed to a more functional community ambulation speed as well as increase endurance. BWSTT was tried to improve patient safety and allow normal arm swing and pelvic rotation at a more normal walking pace, which we set at 1.5-2 mph.

VOR: Vestibulo-ocular Reflex, COG: Center of Gravity, BOS: Base of support, UE: Upper Extremity, LE: Lower extremity, CGA: Contact Guard Assist, SBA: Stand By Assist, MPH: Miles Per Hour, BWSTT: Body Weight Supported Treadmill Training, SW: Standard Walker, AD: Assistive Device, ADL: Activity of Daily Living

Eye-Head Coordination Exercises

Eye-head coordination exercises were initiated because of the patient's impaired gaze stability and difficulty tolerating head movement due to vertigo and nausea. Gaze stabilization was improved in individuals with vestibular nerve or cerebellar pathology following performance of eye-head coordination exercises [8, 18-23]. The patient performed head movements with gaze fixed on a stationary target (VOR X 1) and with gaze fixed on a moving target (VOR X 2) in multiple directions for 2 minutes, 5 times per day starting in sitting and progressing to walking to improve ocular coordination and movement tolerance. Gaze stabilization and postural stability exercises with varying visual and somatosensory inputs encouraged the patient to rely on visual and proprioceptive information to allow more normal movement and balance [19].

Habituation exercises consisting of movements that provoked vertigo and nausea were used to address the patient's motion sensitivity during functional activities. These exercises may work by allowing the brain to accommodate to the mismatch in visual and vestibular inputs. Habituation exercises began in sitting with the patient side bending from the trunk toward one side and down onto his elbow and returning to sitting upright. They were progressed to reaching for balls out of his base of support (BOS) and eventually to standing and reaching down to pick up objects or look overhead to get an object off a high shelf [19].

Balance Training

Due to the patient's trunk instability and difficulty performing all functional tasks, balance training was initiated immediately. Balance tasks performed in a variety of postures increased postural control and balance in patients with ataxia or vestibular deficits; [19, 20, 24] therefore the patient was treated using a variety of functional balance tasks (see Table 4). Static and dynamic balance tasks were progressed by decreasing the amount of support and narrowing the BOS. Dynamic balance and eye-hand coordination were challenged by having the patient reach for stationary cones or a ball progressing to catching and throwing balls. Throwing and catching weighted objects were used to produce more forceful movements out of his BOS. The patient also performed bounce passes to work on timing, coordination of movement and visual tracking [25]. Eventually the patient progressed to balance activities such as "red light-green light" for training sudden stops and reactive balance control, doing single leg step ups onto a BOSU ball (BOSU, Canton, Ohio), and walking through an agility ladder.

Gait Training

Gait impairments in patients with cerebellar dysfunction or vestibular hypofunction/loss have been shown to improve with over ground gait training [19, 20, 24-29]. Gait training began

with the patient standing in the parallel bars with practice of weight shifts and stepping using progressively less arm support. Once the patient could walk with contact guard assistance in the parallel bars, he walked outside of the parallel bars. Due to losses of balance, the patient initially ambulated using a standard walker with 14 pounds added to prevent his tremoring from lifting the walker off the floor and with minimal therapist assistance. His balance and gait improved as shown by a change from a step-to to step-through gait pattern and by his ability to ambulate without therapist assistance, to independently turn with the walker, and to walk backward. A four-wheeled walker was considered to facilitate continuous walking but the patient was unable to ambulate with one because the walker rolled too far forward. He was progressed to using a front-wheeled walker initially with eight pounds added to decrease lift off of the walker, then without weight, and finally with a hemi-walker without weight on the right side due to better right upper extremity coordination making it less difficult to manage. When the patient was able to walk with the hemi-walker with only contact guard assistance, he was trained to walk without an AD with therapist assistance.

To increase the patient's gait speed and endurance, gait training was performed using a treadmill. Recent studies have shown improvements in gait and mobility measures among populations with ataxia and cerebellar lesions following treadmill training either with or without Body Weight Support (BWS) [27, 29]. The patient began his treadmill training at 0.8 mph without handrail support and progressed over time to walking between 2-3 mph for 15-20 minutes. When the patient improved to higher walking speeds (i.e., above 2 mph), the therapist used a harness for BWS to improve patient safety and allow normal arm and pelvic movements. The amount of BWS used was determined by observing whether the patient's knees were extended in standing. Stair training was also initiated at this time with use of two or one handrails along with step up and reciprocal stepping exercises to increase single leg stability for stepping tasks. As the patient progressed to over ground walking with only standby assistance from the therapist, gait training included practice of turns and walking with his gaze fixated on a specific target with or without head movements to mimic walking down a street and "window shopping" which improved gait measures in patients with vestibular dysfunction [18-22, 26].

Outcomes

Outcome measures were assessed at admission and discharge using the BBS, the BARS, and the FIM [15-17]. The BBS was selected because it measures balance performance during a variety of simple functional tasks, is quick to administer with minimal equipment, and is reliable and valid [16, 30]. The fall risk cut-off score for the elderly and those with balance deficits is 45/56 [31] and the Minimal Detectable Change (MDC) was 8.1 points in a stroke population using an ambulatory AD [32]. The BARS, a modification of the International Cooperative Ataxia Rating Scale (ICARS), is a 5 measure test that is reliable and valid in populations with ataxia and takes less time to administer than the ICARS [15]. The maximum score is 30, and lower scores are better. The therapist selected this scale to quantifiably describe the patient's ataxia and track his progress. The FIM motor scale was selected because it measures level of assistance needed for functional tasks and is valid and reliable in neurological populations [17].

The patient initially scored a 0/56 on the BBS and 18/30 on BARS indicating severe activity limitations. After three weeks of intensive training the patient scored a 49/56 on the BBS which placed him at a low fall risk as well as having a clinically meaningful change in scores from admission (Table 2) [31, 32]. The patient also improved dramatically on the BARS scale to a seven out of 30 indicating mild impairment (Table 1). The patient made large improvements in all functional activities as shown by his FIM scores except for rolling in bed which he was independently doing at his initial evaluation (Table 3).

Discussion

This is the first article to describe the successful rehabilitation outcomes of a patient with HSE with acute vestibular neuritis and cerebellitis. Following participation in a three week intensive rehabilitation program focused on eye-head and

habituation exercises, balance and gait training, the patient demonstrated decreased ataxia and significant balance and functional gains as measured by the BARS, BBS, and FIM and by his ability to walk and perform all ADL's independently. At the end of rehabilitation the patient was able to ambulate with stand by assistance without an AD, and modified independent with a hemi-walker. Our findings offer preliminary evidence that an intensive rehabilitation program that specifically targets gaze instability, motion sensitivity, balance and gait impairments and activity limitations can be beneficial in patients with complex balance disorders caused by vestibular and cerebellar dysfunction.

The overall outcomes of the eye-head coordination and habituation exercise interventions in this study are consistent with previous literature on patients with unilateral peripheral or central vestibular dysfunction in terms of ability to tolerate movement, and improvements in balance, gait speed, and functional outcomes [8, 18-29]. Performance of gaze stabilization and habituation exercises similar to those done by the patient in this case report produced decreased dizziness and increased tolerance to movement in patients with unilateral vestibular hypofunction or cerebellar pathology [18-23, 26]. VOR exercises combined with balance training on various surfaces and widths of BOS have also been shown to increase balance, decrease fall risk and dizziness, [19-21] which is consistent with the outcomes of the patient in this case report, who performed similar types of balance exercises.

The balance and mobility outcomes in this study are consistent with other studies which found that intensive balance and gait training [i.e., progressive balance interventions (static to dynamic, wide BOS to narrow BOS, stair training, fall recovery training, and functional movement balance training) and gait training on firm and compliant surfaces] effectively improved gait, balance, and mobility in individuals with truncal and gait ataxia due to cerebellar or peripheral vestibular lesions [21, 24]. The patient improved functionally from maximal assistance sitting at the edge of bed to being independent without arm support, allowing him to independently dress himself, do self-care activities and feed himself. The patient walked initially with maximal assistance of two people and progressed to walking independently with a hemi-walker and only needing stand by assist to walk up to 200 feet without an AD. As the patient's ability to stabilize his gaze improved, he demonstrated less path deviation as evidenced by an ability to ambulate without having to focus his gaze straight ahead, but instead to walk with head turns or speak with a family member at his side without veering or loss of balance.

The patient's improvement on the BBS dramatically lowered his fall risk and met the MDC (8.1 scale points) for the BBS [31, 32]. When this patient began his rehabilitation stay, he was unable to complete any of the items on the BBS without loss of balance or maximal assistance and therefore scored a 0/56. After 3 weeks of treatment he progressed to a score of 49/56. At the end of treatment, the patient continued to have difficulty with higher level balance tasks such as tandem stance, single limb stance, functional reach and step-tap items on the BBS.

At the completion of his physical therapy treatment, the patient demonstrated a considerable reduction in his ataxia as measured on the BARS. Although changes in BARS scores do not necessarily correlate with functional outcomes, the scale does provide a concise clinical picture of the patient's ataxia before and after treatment. The patient had marked improvements in oculomotor control and limb coordination as well as marked reductions in tremoring that allowed more functional use of his arms for arm tasks and self-care activities.

There are some limitations to this study. Due to the unique nature of this patient's diagnosis, it is difficult to apply these findings to the general population. Further research on the effects of balance and gait training and vestibular rehabilitation in patients with concomitant vestibular and cerebellar deficits would be beneficial. Because the patient was being treated with acyclovir, it is not possible to distinguish whether his functional improvements were due to the medications that he was taking or to the physical therapy interventions. The patient's young age and the fact that he received other therapeutic interventions were positive prognostic factors for his recovery. Use of additional objective measures such as gait speed and the Dizziness Handicap Inventory would have been beneficial to

assess changes in the patient's self-perceived ratings of dizziness as well as to correlate gait speed with risk for falls and community mobility status after treatment.

Summary

The rehabilitation of individuals with severe ataxia and imbalance secondary to vestibular and/or cerebellar pathology is a significant challenge for physical therapists. The individual in this case report showed dramatic improvements in his static and dynamic balance, ability to care for himself and complete ADL's, and his level of independence with gait after an intensive physical therapy program that utilized evidence-based interventions to target specific impairments. This case report may provide therapists with a framework for clinical decision making regarding patients with multiple balance systems deficits and how they may be successfully treated with a variety of strategies to address each system and impairment.

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