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Vestibular Rehabilitation For A 17-Year Old Female With Post-Concussion Symptoms: A Case Report

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The patient signed an informed consent allowing for the use of medical information and photographs for this report and received information on the institution's policies regarding the Health Insurance Portability and Accountability Act.

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Abstract:

Background: Post-concussion syndrome is defined as a group of symptoms occurring after a traumatic brain injury (TBI) that can persist for durations ranging from weeks to years. The Centers for Disease Control and Prevention estimates that 1.7 million Americans experience TBI annually. Vestibular rehabilitation has been shown to help alleviate common symptoms after concussions, such as dizziness, headaches and impaired balance. The purpose of this case report is to describe the physical therapy management of a patient with post-concussion symptoms two months post-injury.

Case Description: The patient is a 17-year-old female with a history of concussion following a syncopal episode two months prior to the initial evaluation. The patient was referred to physical therapy for evaluation and treatment of continued post-concussion symptoms including headaches and dizziness that worsened with activity. The examination indicated impaired static and dynamic balance. An impaired vestibular ocular reflex was indicated by dynamic visual acuity testing and a positive head thrust test.

Outcomes: Following five weeks of vestibular rehabilitation, including static and dynamic balance exercises, as well as gaze stabilization, the patient reported improvement in the frequency of dizziness symptoms allowing return to school and work as a waitress. The patient showed significant improvement in all functional testing, including the dizziness handicap inventory, functional gait assessment, balance error scoring system test and the four-square step test.

Discussion: The patient's improvement in dizziness, headaches, static and dynamic balance, and improved vestibular ocular reflex demonstrate the potential benefits of vestibular rehabilitation for a patient suffering from post-concussion symptoms. Further research needs to be conducted

comparing individuals with concussions who receive vestibular rehabilitation to those who recover with rest only.

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Background and Purpose:

Post-concussion syndrome is defined as a group of symptoms occurring after a traumatic brain injury (TBI) that can persist for durations ranging from weeks to years.[1] The diagnosis of post-concussion syndrome is not well agreed upon in the literature, but does include at least three of the following symptoms: headache, dizziness, fatigue, irritability, insomnia, concentration or memory difficulty, and intolerance of stress or emotion.[1] The Centers for Disease Control and Prevention estimates that 1.7 million Americans experience TBI annually.[1] However, the actual reported incidence of TBI is estimated to be much lower secondary to individuals failing to seek medical attention to obtain a definitive diagnosis.[2]

Following a concussion, the brain is in an "energy crisis" state due to sudden increase in glucose metabolism and a decrease in cerebral blood flow, which results in a mismatch of energy supply and demand.[3] Both cognitive and physical activities require brain energy utilization, therefore the need for a period of cognitive and physical rest is critical for recovery. The current guidelines for the management of a concussion include complete physical and cognitive rest until the patient's acute symptoms have resolved.[4] Complete cognitive rest can be challenging because it involves minimizing any potential cognitive stressors to the brain, such as school work, video games, reading, watching television, cell phone use, and listening to music. Although the need for a period of complete rest period is agreed upon, the optimal amount of time for this rest period is not well represented in the literature. Willer et al[5] states that the clinically accepted standard is to limit activity until the patient no longer has symptoms at rest.

Vestibular rehabilitation has been shown to improve common symptoms that develop after a concussion, including vertigo, dizziness and imbalance.[3,6] After an exhaustive literature review, no studies were found that compare the effects of vestibular rehabilitation following a concussion to individuals that recover with rest only. The purpose of this case report is to describe the physical therapy management using vestibular rehabilitation of an adolescent female with post-concussion symptoms two months post-injury.

Patient History and Systems Review:

The patient was a 17-year old female who was originally examined in the Emergency Department (ED) two months prior to her initial evaluation in physical therapy after a vasovagal syncope episode, which resulted in a head injury. The patient had no prior history of syncope with exertion and an unremarkable medical history. The patient's medications included magnesium and she received monthly B12 injections. At the time of evaluation, the patient had returned to school to attend classes, but was unable to participate in school work due to increased severity of symptoms. She also reported non-compliance with relative brain rest that had been recommended by her physician. The patient's goals for therapy included to return work as a waitress symptom free and to return to school full time in order to graduate from high school two months from presentation to therapy. The patient signed an informed consent allowing for the use of medical information for this report and received information on the institution's policies regarding the Health Insurance Portability and Accountability Act.

Clinical Impression #1:

The patient was referred to physical therapy for vestibular rehabilitation two months following her concussion for continued complaints of headaches and dizziness. She was not referred earlier due to lack of transportation and a limited schedule. The patient's primary complaint of dizziness with activity, specifically head movements, limited her ability to

participate in school and at work. A complete vestibular examination was completed in order to rule out the potential differential diagnoses for dizziness, such as benign paroxysmal positional vertigo (BPPV), which is commonly seen in patients following a concussion[6] Based on the patient's mechanism of injury, further examination of the patient's cardiovascular system was needed to assess for symptoms consistent with orthostatic hypotension. (See table 1. for systems review)

The patient's examination included the following systems: musculoskeletal, neuromuscular, cardiovascular and integumentary. She was given the Dizziness Handicap Inventory (DHI) prior to examination to assess the impact of symptoms on her function (See Appendix 4). The history included important questions regarding the duration and frequency of symptoms, sensitivity to motion, such as driving or taking an elevator, and sensitivity to certain head positions. Auditory and balance history, neck pain and migraine history were to be included. Ocular motor exam including smooth pursuits, saccades, convergence and VOR cancellation were assessed. A cervical exam was performed, including range of motion and the vertebral artery test. VOR testing, including the head thrust test, dynamic visual acuity (DVA) and cerebellar testing, specifically coordination, were completed. Testing for BPPV included the modified Dix-Hallpike and the lateral test to assess the anterior, posterior and horizontal semicircular canals. Balance was assessed using the GANS Sensory Organization Performance (SOP) test (see appendix 1), Balance Error Scoring System (BESS) test (see appendix 2) and the Four Square Step Test (see appendix 3). Gait would be assessed using the Functional Gait Assessment (FGA) and gait speed. Since this concussion resulted from a syncope episode, blood pressure would be taken in supine, sitting and standing to assess for orthostatic hypotension. (See Table 2. for Tests and Measures)

Clinical Impression #2:

The information obtained in the examination, as well as the patient's continued symptoms of dizziness and headaches that increased with activity, confirmed the initial diagnosis of concussion with vestibular symptoms. Information obtained from the history, including the patient's complaints of dizziness lasting a few seconds with all head positions at increased speed and with walking at a fast pace, as well as complaints of headaches with reading, fluorescent lights and loud noises, were all consistent with signs and symptoms of a concussion. The patient also noted differences in her balance over the past few weeks, which research has shown is a common finding following a concussion.[3] Since there are multiple causes for dizziness, the examination required several tests and measures to rule out potential differential diagnoses. The patient's complaints of dizziness with ocular motor range of motion and saccades indicated an impaired vestibular ocular reflex (VOR). The patient had full cervical range of motion and a negative modified vertebral artery test, which gave reason to believe that the dizziness was not a result of a vascular issue.

The patient's VOR testing, including the head thrust test and DVA test indicated a significant impairment in the patient's VOR with a corrective saccade with head movement to the right and with complaints of dizziness during DVA testing. The patient tested negative for BPPV on both the modified Dix-Hallpike and lateral test. Results from the Gans SOP test, FGA, FSST, and the BESS test indicated that the patient's static and dynamic balance was impaired. The patient also presented with symptoms consistent with orthostatic hypotension based on blood pressure readings. After the initial evaluation, the patient continued to be appropriate for physical therapy and the decision was made to proceed with interventions. (See Table 3. for Test and Measures)

The primary diagnosis of, "Impaired motor function and sensory integrity associated with non-progressive disorders of the central nervous system-acquired in adolescence or adulthood" was selected from the *Guide to Physical Therapy Practice* with relevant ICD-9-CM code (850 "Concussion"). Based on the patient's age, prior health status, prior activity level, motivation and family support, her prognosis for physical therapy was good. However, the delay of two months in the initial referral to physical therapy had the potential to impact the patient's overall progress and improvement in symptoms. The patient's improvement in function would be affected by the compliance with her home activity program and with restriction of activity that caused exacerbation of her symptoms.

Interventions:

The plan for physical therapy included two visits each week for eight weeks or until the patient's symptoms had resolved and she was fully able to return to her prior level of function at school and work. However, due to issues with transportation and her schedule, the patient was only seen for 5 visits over a 4 week period. Interventions included gaze stabilization, static balance on various surfaces, oculomotor ROM, saccades and dynamic mobility exercises that specifically targeted the patient's VOR. The patient began each session on the Monark bike* for a total of 5 minutes in order to assess for changes in symptoms associated with physical exertion. (See Table 4 for Interventions).

Gaze stabilization:

Gaze stabilization exercises were specifically incorporated into the patient's home exercise program since her primary complaint was dizziness with quick head movements. The patient was given instructions on VOR X 1 viewing exercises to be completed at home three

* Monark 827E Cardio Care Fitness Exercise Bike: Healthcare International. Inc PO Box 1509 Langley, WA 98260

times a day, which had the patient focusing her eyes on a target (a four letter word on a piece of paper held at an arm's length away) while she moves her head from left to right quickly with a goal of reaching of 120 seconds (See Figure 1. for Gaze Stabilization). The patient repeated the same exercise, but moved her head up and down for another 120 seconds. Viirre et al[7] demonstrated that when a foveal stimulus is presented while the head is moving, improvements in the function of the VOR are seen. Gaze stabilization was also incorporated into many of the other interventions described below. Gaze stabilization exercises were progressed by changing the patient's position from sitting to standing and progression was indicated when the patient could perform the task for the full 2 minutes without stopping due to symptoms. Once the patient could tolerate the full 120 seconds of VOR x 1 viewing exercises while standing, the patient was introduced to VOR x 2 viewing, which again had the patient focusing on a target, but now her head moved in the opposite direction of the object.

Static balance on various surfaces:

Normally, postural control is maintained through integration of three systems: visual, vestibular and somatosensory.[3] Following a concussion, a patient may demonstrate difficulty with re-weighting the sensory information with changes in the environment.[3] Interventions to address this included challenging the patient with static balance exercises on various surfaces, such as a tilt board[†], airex foam pad[‡], and trampoline[§]. The vestibular system was specifically targeted by having the patient close her eyes while performing head movements horizontally and then again vertically, similar to gaze stabilization. The patient was further challenged with balance exercises on various support surfaces by changing the patient's base of support, having

[†] Fitterfirst Professional 20" Rocker board P.O. Box 21 De Queen, AR 71832 US
[‡] Airex foam pad: Industrie Nord 26 CH-5643 Sins Switzerland
[§] Plyoback Elite Plus Rebounder 360 Veterans Parkway, Suite 115 Bolingbrook, IL 60440-4607 United States

her close her eyes, and adding horizontal and vertical head turns with fixation of her eyes on a specific target (See Figures 2 and 3 for Static Balance Interventions).

Oculomotor ROM and saccades:

Oculomotor ROM, saccades and ball circles involved the patient following a target with her eyes only in all directions (horizontally, vertically and diagonally) while keeping her head still. During saccades, the patient quickly shifter her gaze between two objects without moving her head. The objects were continuously moved from a horizontal, vertical or diagonal orientation by the therapist (See Figure 4 for Saccades Intervention). Ball circles involved the patient standing on an unsteady surface, such as an airex foam pad or ½ foam, while the patient holds a ball in her hand and moves it around in circles both clockwise and counterclockwise. She was instructed to follow the ball with just her eyes at first and then moved her eyes and head at the same time (See Figure 5). These exercises were progressed by changing the patient's standing surface from solid ground, to an airex foam pad to ½ foam.

Dynamic mobility:

Dynamic balance activities included ambulation with horizontal and vertical head turns, as well as change of direction with freezing, which were all initiated by the therapist. (See Figure 6 for Dynamic Balance Intervention). Cognitive tasks, such as naming 5 colors, counting backwards from 50 by 3's, and naming the months of the year backwards from December, were incorporated into both static and dynamic balance activities. Studies have shown that patients who have had a concussion have more difficulty maintaining postural control under dual-task conditions.[8] Dual-tasks result in competition for attention and an increase in cognitive load, which typically decreases performance in one or both of the tasks. [8] Therefore, the purpose of the addition of cognitive tasks to balance exercises was to further challenge the patient. Research

has also shown that patients who have had a concussion present with greater response times, less efficient gait strategies, and greater postural control deficits compared with healthy individuals.[8] These deficits are even more apparent under dual-task conditions.

Coordination, communication and documentation

All aspects of documentation, including examination, evaluation, diagnosis, prognosis and plan of care were discussed with the patient and the referring physician.

Outcomes:

Following four weeks of vestibular rehabilitation, the patient had achieved all of her functional goals for therapy. She reported improvement in the frequency of her dizziness symptoms, and her post-concussion symptoms no longer impaired her function. She demonstrated improvements in static and dynamic balance, as well as VOR function. She was able to return to work as a waitress and complete necessary school work in order to graduate two months post-injury. (See Table 2 for Test and Measures at Discharge and Figure 7 for Functional Outcomes Measures Results).

Discussion:

The patient's improvement in her symptoms of dizziness and headaches, static and dynamic balance, and improved VOR, which had not improved with rest, show the potential benefits of vestibular rehabilitation for a patient suffering from post-concussion symptoms. Other studies have demonstrated the potential benefits of vestibular rehabilitation for the management of concussions.[3, 6, 9] Schneider at al[9] conducted a randomized control trial that compared the treatment of 31 individual's ages 12-30 years old who had prolonged post-concussion symptoms of dizziness, neck pain and/or headaches following a sports-related concussion. The study compared a physical therapy treatment group, which received vestibular rehabilitation, including

habituation exercises, gaze stabilization, standing and dynamic balance exercises, and canalith repositioning maneuvers to a control group, which followed the current standard of care protocol for sport-related concussion, which was rest followed by gradual exertion. The study looked at the effect of both treatments on the amount of time until the subjects had medical clearance to return-to-play. The study found that treatment group participants were 10.27 (98% CI 1.51-69.56) times more likely to be medically cleared to return-to-sport before 8 weeks compared with the participants in the control group ($p < 0.001$). This study further demonstrated the benefits of vestibular rehabilitation in improving symptoms of individuals following a concussion.

The patient performed three repetitions of gaze stabilization exercises daily and these exercises were also incorporated into both static and dynamic balance interventions during treatment sessions. Previous research has shown that gaze stabilization decreases symptoms of dizziness and increases function in individuals with vestibular disorders. The patient's improvement on the DHI of 46 points demonstrates this improvement in her symptoms and function, as well as increased tolerance when performing the VOR x 1 viewing exercises each session. Gaze stabilization exercises allow for the vestibular system to modify the magnitude of the VOR in response to head movement and therefore are an important intervention to consider when the VOR is impaired.

The patient's improvement in both static and dynamic balance was demonstrated by improvement on three functional outcome measures. The patient improved her time on the four square step test by almost 5 seconds showing her improvement in not only dynamic balance, but coordination. She demonstrated 9 fewer errors on the BESS test and improved by 5 points on the FGA to achieve a perfect score. These results further demonstrate the potential benefits of vestibular rehabilitation for improving a patient's balance.

The addition of a cognitive task while performing static and dynamic balance training helped to evaluate the patient's continued impairments of balance throughout her treatment. A balance task that failed to challenge the patient once her balance started to improve became more difficult for her when she had to perform that same balance activity while performing a simultaneous cognitive task. A systematic review[8] found that concussed individuals resemble healthy controls when gait and cognitive tasks are performed separately. However, under dual-task conditions concussed individuals demonstrated a more conservative gait strategy. These findings suggest the need for dual-task training in order to assess whether or not an individual continues to present with impairments in balance.

Research has shown that vestibular rehabilitation may improve persistent dizziness, gaze instability, gait and balance dysfunction in patients following concussions and should be considered in the management of these individuals.[6] The results of this case are in agreement with this recommendation. Despite some research showing the benefits of vestibular rehabilitation on post-concussions symptoms, further research needs to be conducted comparing individuals with concussions who receive vestibular rehabilitation and those who recover with rest only.

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Table 1. Systems Review

Systems	Impaired vs. non-impaired
Cardiovascular/Pulmonary	Impaired cardiovascular system
Musculoskeletal	Not impaired
Neuromuscular	Impaired balance and coordination
Integumentary	Not impaired
Communication, Affect, Cognition, Language	Impaired cognition
Learning Style	Written instructions, pictures and demonstrations

Table 2. Tests and Measures at Initial Evaluation and Discharge

Tests & Measures	Initial Evaluation Results	Discharge Results	Reliability	Validity
Dynamic Visual Acuity Test	Horizontal +1 Vertical +1 (patient c/o dizziness; vertical was worse)	Horizontal and vertical + 2 with no c/o dizziness	Excellent test-retest reliability (r=0.94)[11]	Excellent (r= 0.72) correlation of DVA loss and VOR gain measured during quantitative passive head impulsive testing[12]
Modified Dix-Hallpike	Negative bilaterally	N/A	Excellent inter-rater reliability	The Dix-Hallpike test is the most common

			(r = 0.92)[13]	positional test used to examine for BPPV in the anterior and posterior canals[14]
Lateral Test	Negative bilaterally	N/A	N/A	The lateral test is used to assess BPPV in the horizontal canal[14]
GANS SOP test (Sensory Organization Performance Test):	Sway with #2,4 and 6	Balance was assessed using other outcome measures.	Test-retest reliability (ICC = 0.67)[15]	Adequate correlation (-0.31) between DHI emotional score and mean sway in condition 3.[16]
Functional Gait Assessment:	25/30	30/30	Excellent test-retest reliability in patients with stroke (ICC = 0.95, 95% CI)[17]	Excellent concurrent validity with: DHI (*r* = -0.64)[18]
Balance Error Scoring System Test:	16 errors	7 errors	Adequate test retest reliability in youth participants aged 9-14 (ICC = 0.70)[19]	Adequate correlation with ImPACT Impulse control (*r* = -0.31) [20]
Four Square Step Test:	9.25 seconds (average)	4.79 seconds (average)	Excellent test-retest reliability (ICC=0.93)[21]	Adequate concurrent validity with gait speed (r=0.65) [22]
Dizziness Handicap Inventory	52/100 (lower score = better function)	6/100	Excellent test-retest reliability (r =0.97)[23]	Excellent negative correlation between scores of DHI and ABC (*r* = 0.64)[20]
Head 'thrust' test	Positive right with corrective saccade	Not tested at discharge secondary to lack of time during visit.	Good test-retest reliability (r=0.73)[24]	Unable to find information regarding the validity of the head thrust test. The head thrust test is used to assess the function of the semicircular canals[14]
Blood Pressure to Test for Orthostatic	Supine 108/58 mmHg Sitting 108/66	Not tested at discharge secondary to	Healthy volunteers, medium-term (1	Reproducibility of cardiovascular responses

Hypotension	mmHg Standing 90/70 mmHg	patient not experiencing any symptoms throughout treatment.	week) and long-term (1 year) baroreflex responses proved to be reliable (r=0.54–0.87) [25]	has been inconsistent.

Abbreviations: c/o (complaints of), DVA (Dynamic visual acuity), VOR (Vestibular ocular reflex), BPPV (Benign paroxysmal positional vertigo), DHI (Dizziness handicap inventory), ABC (Activity specific Balance Confidence Scale), IMPACT (Immediate Post-Concussion Assessment and Cognitive Testing)

Table 3. Interventions

	IE (8 weeks PC)	Visit 2 (9 weeks PC)	Visit 3 (10 weeks PC)	Visit 4 (10 weeks PC)	Visit 5 (11 weeks PC)
VOR x 1 viewing (seated)	H x 22” V x 22”	H x 21, 29 and 33” V x 20, 30, and 33”	H x 81 and 64” V x 83 and 80”	H x 120” V x 120”	H x 120” V x 120” (standing)
Oculomotor ROM		x 20 #	x 20 #	x 20 #	
Saccades		x 20 #	x 20 #	x 20 #	
Ball Circles		x 20 #	x 20 #	x 20 #	
VOR x 1 reading			H x 120” V x 120” (sitting)	H x 120” V x 120” (sitting)	H x 120” V x 120” (standing)
EC H and V head turns on unstable surface		Foam: EC x 60” H x 10 V x 10		½ Foam: EC x 30” H x 20 V x 20	
Trampoline		H x 15 V x 15 Fixation while bouncing x 20 Ankle sways x 20 EO x 20 EC	EO x 30” EC x 30” EC with H and V head turns x 20 each Fixation while bouncing EC x 20 Marching with EC x 20	EO x 30” EC x 30” EC with H and V head turns x 20 each Fixation while bouncing EC x 20 Marching with EC x 20	

Tilt-board		A and P with EC x 20 Lateral with EC x 20	A and P with EC x 20 Lateral with EC x 20 A and P with EC with V x 20 Lateral with EC with H x 20	A and P with EC x 20 Lateral with EC x 20	
Unilateral stance with ball toss		x 10 each leg	X 15 each leg	X 20 each leg	
Dynamic mobility			H and V x 40 feet each Ambulation with freeze x 20 feet Freeze and turn x 20 feet	Ambulation with random H and V with EC and freeze x 120 feet	
VOR x 2 viewing (seated)					H x 120” V x 120”

Abbreviations: IE (initial evaluation), PC (post-concussion), VOR (vestibular ocular reflex), H (horizontal), *(patient experienced dizziness and nausea),” (seconds), V (vertical), ROM (range of motion), # (repetitions), EC (eyes closed), EO (eyes open), A (anterior), P (posterior).

Figure 1. Gaze stabilization Exercises (VOR x 1 viewing)

Figure 2. Static Balance on Tilt-board with vertical head movements

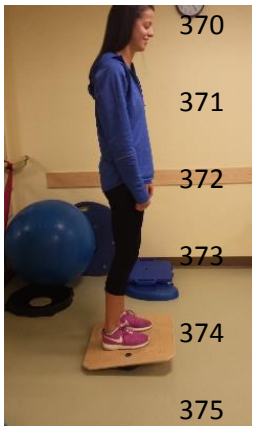


Figure 3. Static Balance (Single-leg stance on airex foam pad with ball toss against trampoline)

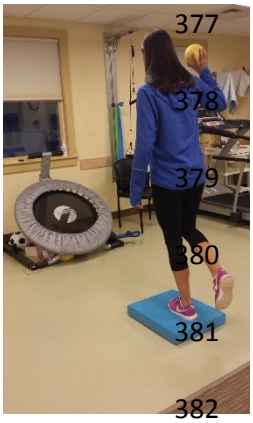


Figure 4. Saccades (Horizontal orientation)

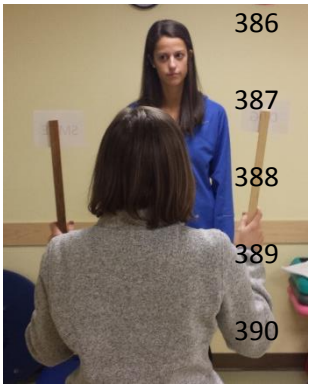


Figure 5. Ball Circles on Tilt-board (patient following the ball with her eyes only)

Figure 6. Dynamic Balance (Ambulation with horizontal head while performing a cognitive task)

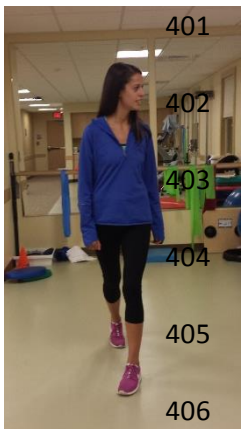
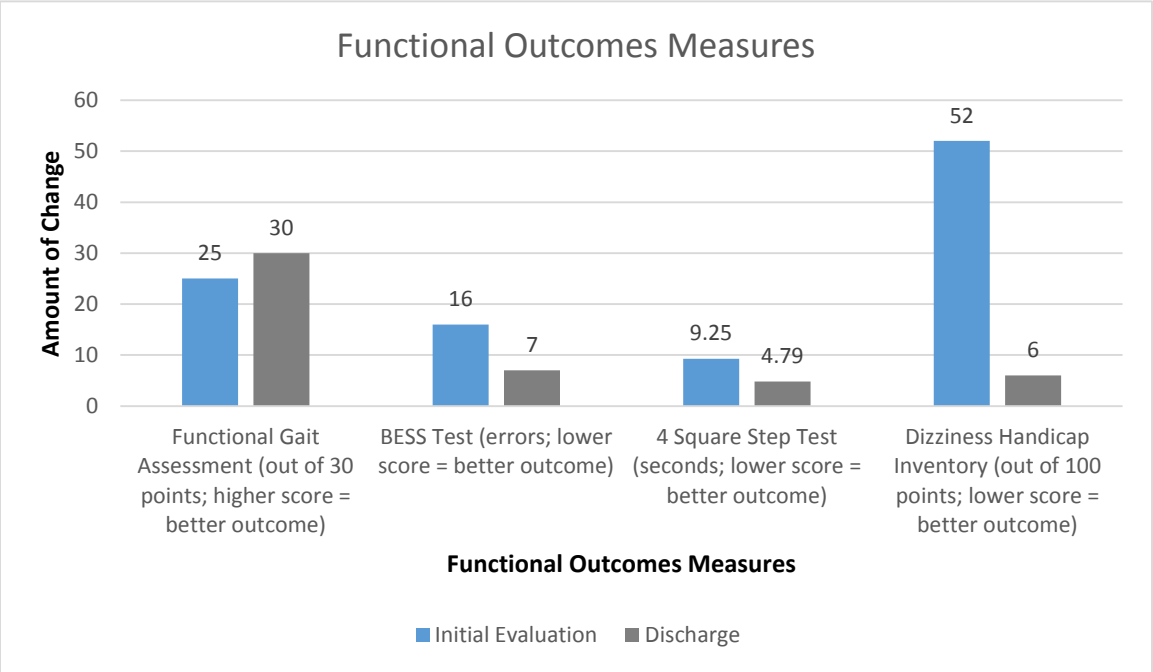
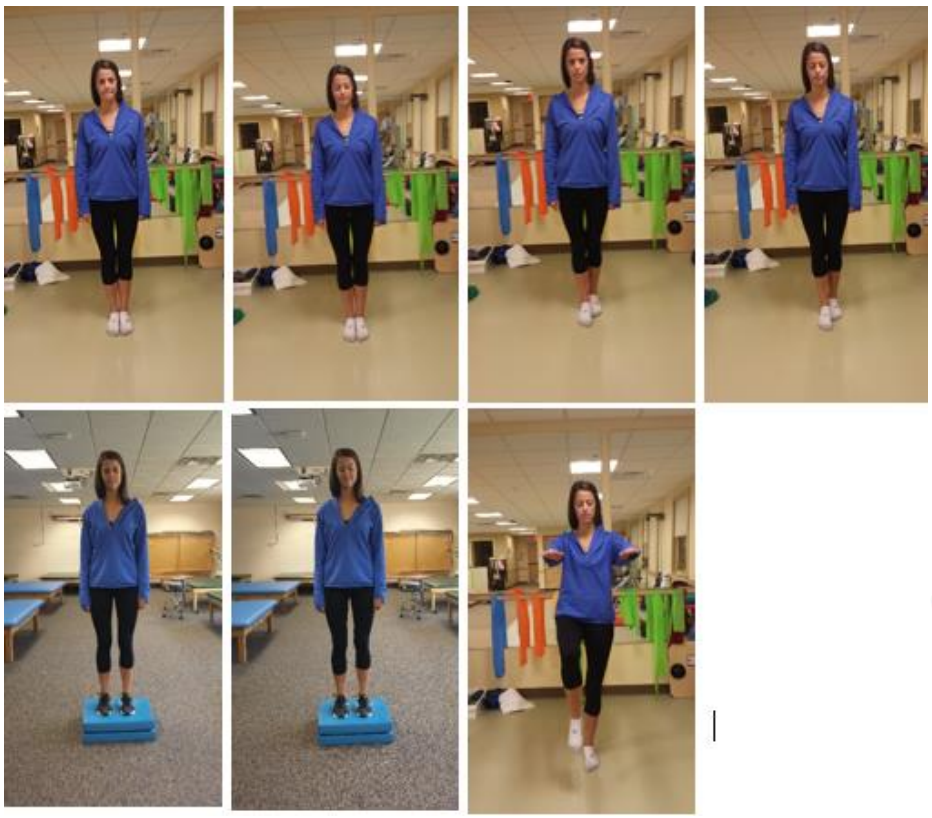


Figure 7. Functional Outcome Measures at Initial Evaluation and Discharge



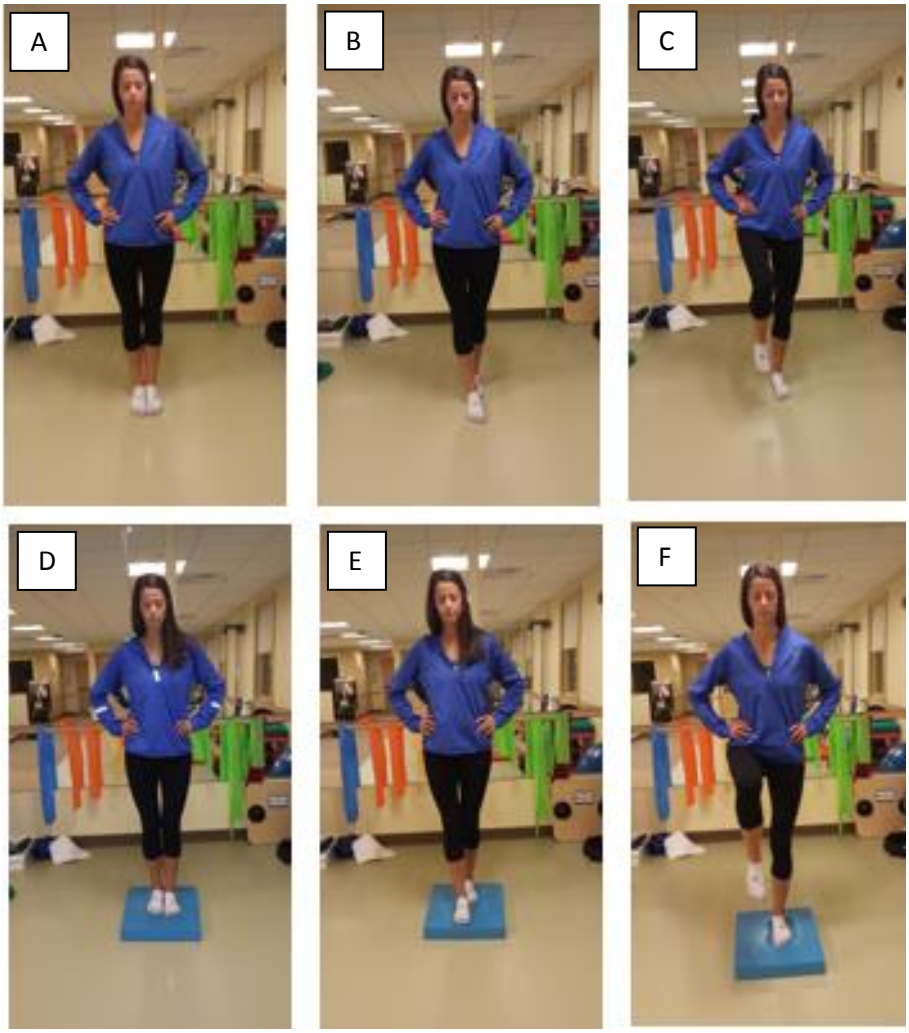
Appendix 1. Gans Sensory Organization Performance Test



The Gans SOP test is a combination of the Romberg, clinical test of sensory integration of balance (CTSIB) and the Fukuda stepping test. It includes seven different positions, as shown above, and with each positon the therapist is evaluating for whether or not there is sway or if the patient falls. The patient begins by standing on a firm surface with feet together with eyes open, next the patient is in the same position, but with eyes closed. In third and fourth position, the patient is in semi-tandem stance with eyes open and then eyes closed. The fifth and sixth positions are performed on the AIB balance performance foam, pictured above, again with eyes open first and then eyes closed. The last position the patient is told to march in place with eyes open at first and then with eyes closed. The therapist is looking to see if the patient deviates either to the left or right, which indicates unilateral vestibular hypofunction.

The American Institute of Balance <http://www.rehab.msu.edu/_files/_docs/Dizziness_Handicap_Inventory.pdf> Accessed September 27th, 2015

Appendix 2. Balance Error Scoring System (BESS)



A: Double leg stance on a firm surface: Standing with feet side by side (touching), hand on hips and eyes closed

B: Tandem stance: Standing heel to toe on a firm surface with the non-dominant* foot in the back. Heel of the dominant foot should be touching the toe of the non-dominant foot. Hands are on the hips and eyes are closed.

C: Single leg stance: Standing on a firm surface on the non-dominant foot, the hip is flexed to approximately 30 degrees and knee flexed to approximately 45 degrees. Hands are on the hips and eyes are closed.

D: Double leg stance on foam surface: Standing with feet side by side (touching), hand on hips and eyes closed

E: Tandem stance: Standing heel to toe on a foam surface with the non-dominant foot in the back. Heel of the dominant foot should be touching the toe of the non-dominant foot. Hands are on the hips and eyes are closed.

F: Single leg stance: Standing on a foam surface on the non-dominant foot, the hip is flexed to approximately 30 degrees and knee flexed to approximately 45 degrees. Hands are on the hips and eyes are closed.

*non-dominant leg: defined as the leg opposite of the preferred kicking leg

The goal of each position is to be able to stand in the given position for a total of 20 seconds, Errors are counted for each of the six positions and the max total number of errors for any single condition is 10. If a subject commits multiple errors simultaneously, only one error is recorded. An error is marked if the patient does the following: opens eyes, takes a step, stumbles or falls, takes hands off hips, abducts or flexes the hip greater than 30 degrees, lifts the forefoot or heel off the testing surface, or remains out of the proper testing position for greater than 5 seconds,

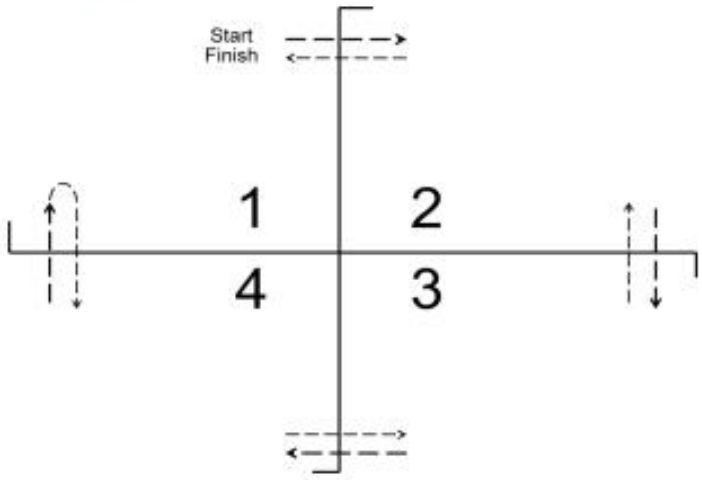
490 Appendix 3. Four Square Step Test

Four Step Square Test Instructions

General Information:

- The patient is instructed to stand in square 1 facing square number 2 (see figure below)
- The patient is required to step as fast as possible into each square in the following sequence: 2, 3, 4, 1, 4, 3, 2, and 1
  - requires the patient to step forward, backward, and sideway to the right and left
- Equipment required for the FSST includes a stopwatch and 4 canes.

Set-up (derived from Dite and Temple 2002): A square is formed with the 4 canes by resting them flat on the floor.



Patient Instructions (derived from Dite and Temple 2002):

- "Try to complete the sequence as fast as possible without touching the sticks. Both feet must make contact with the floor in each square. If possible, face forward during the entire sequence."
- Demonstrate the sequence to the patient.
- Ask the patient to complete one practice trial to ensure the patient knows the sequence. Repeat the trial if the patient is unsuccessful

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at completing the sequence, loses balance, or contacts a cane during the trial.
- Two FSST are completed with the best time taken as the score.
- A score is still provided if the patient is unable to face forward during the entire sequence.

Scoring:
- the best time of two FSST is the score
- stopwatch starts when the first foot contacts the floor in square 2
- stopwatch finishes when the last foot comes back to touch the floor in square 1

Four Square Step Test Instructions. Rehab Measures website. < http://www.rehabmeasures.org/PDF%20Library/Four%20Step%20Square%20Test%20Instructions.pdf> Accessed September 27th, 2015

513 Appendix 4. Dizziness Handicap Inventory

Dizziness Handicap Inventory

Instructions: The purpose of this scale is to identify difficulties that you may be experiencing because of your dizziness. Please check "always", or "no" or "sometimes" to each question. Answer each question only as it pertains to your dizziness problem.

	Questions	Always	Sometimes	No
P1	Does looking up increase your problem?	☐	☐	☐
E2	Because of your problem, do you feel frustrated?	☐	☐	☐
F3	Because of your problem, do you restrict your travel for business or pleasure?	☐	☐	☐
P4	Does walking down the aisle of a supermarket increase your problem?	☐	☐	☐
F5	Because of your problem, do you have difficulty getting into or out of bed?	☐	☐	☐
F6	Does your problem significantly restrict your participation in social activities, such as going out to dinner, going to movies, dancing or to parties?	☐	☐	☐
F7	Because of your problem, do you have difficulty reading?	☐	☐	☐
F8	Does performing more ambitious activities like sports, dancing, and household chores, such as sweeping or putting dishes away; increase your problem?	☐	☐	☐
E9	Because of your problem, are you afraid to leave your home without having someone accompany you?	☐	☐	☐
E10	Because of your problem, have you been embarrassed in front of others?	☐	☐	☐
P11	Do quick movements of your head increase your problem?	☐	☐	☐
F12	Because of your problem, do you avoid heights?	☐	☐	☐
P13	Does turning over in bed increase your problem?	☐	☐	☐
F14	Because of your problem, is it difficult for you to do strenuous housework or yard work?	☐	☐	☐
E15	Because of your problem, are you afraid people may think that you are intoxicated?	☐	☐	☐
F16	Because of your problem, is it difficult for you to go for a walk by yourself?	☐	☐	☐
P17	Does walking down a sidewalk increase your problem?	☐	☐	☐
E18	Because of your problem, is it difficult for you to concentrate?	☐	☐	☐
F19	Because of your problem, is it difficult for you to walk around your house in the dark?	☐	☐	☐
E20	Because of your problem, are you afraid to stay home alone?	☐	☐	☐
E21	Because of your problem, do you feel handicapped?	☐	☐	☐
E22	Has your problem placed stress on your relationship with members of your family or friends?	☐	☐	☐
E23	Because of your problem, are you depressed?	☐	☐	☐
F24	Does your problem interfere with your job or household responsibilities?	☐	☐	☐
P25	Does bending over increase your problem?	☐	☐	☐

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515 Dizziness Handicap Inventory. Rehab Measures website.
516 <http://www.rehab.msu.edu/_files/_docs/Dizziness_Handicap_Inventory.pdf> Accessed
517 September 27, 2015