2018

Physical Therapy Management of a Patient with Post-Concussive Syndrome Following a mTBI: A Case Report

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Abstract

Background: Prolonged symptoms following a concussion, known as post-concussion syndrome (PCS) is beginning to gain relevance in recent literature. There is some evidence indicating the adverse effects of PCS on a patient's life, the evaluation of PCS, and the treatment of PCS. **Purpose:** The purpose of this case study is to provide examples of interventions and progressions used to successfully treat a patient experiencing symptoms related to PCS following a mild traumatic brain injury (mTBI). **Case Description:** A 55-year-old male referred to therapy 2-weeks after experiencing a diagnosed mTBI. His pertinent medical history included 4 diagnosed mTBI in the past. He was experiencing symptoms including a constant headache, increased cervical stiffness and pain, dizziness, increased frustration, difficulty sleeping, and impaired balance and lower extremity coordination. **Interventions:** He received 14 physical therapy sessions over an eight-week period, while also receiving speech therapy. The physical therapy interventions included manual therapy and postural strengthening, vestibular and oculomotor training, balance interventions, and work simulated tasks. **Outcomes:** The patient was evaluated using certain parts of the vestibular/ocular motor screening (VOMS) exam as well as the concussion balance test (COBALT). The patient returned to his previous level of employment indicating an improvement in overall function. His reported pain levels decreased from 6/10 upon evaluation to 0/10 on the final day of therapy. **Discussion:** Throughout his episode of care, he demonstrated improvements in cervical stiffness and pain, lower extremity coordination, balance, and a large reduction in his experienced headache and dizziness. This case report outlines the interventions used in a specific patient aimed to resolve the experienced symptoms presumably due to PCS.

Keywords: Traumatic brain injury; post-concussive syndrome; sports medicine; neurology; physical therapy; rehabilitation

Background

A Mild Traumatic Brain Injury (mTBI) or what is commonly known as a "concussion" has a variety of causes, but the symptoms generally resolve on their own. If the symptoms do not resolve on their own in a timely manner, a new diagnosis is gaining popularity, now commonly known as "Post-Concussion Syndrome" (PCS). The symptoms of PCS as listed in the Post-Concussion Symptom Scale include the following: headache, nausea, vomiting, balance problems, dizziness, fatigue, trouble falling asleep, excessive sleep, loss of sleep, drowsiness, light sensitivity, noise sensitivity, irritability, sadness, nervousness, more emotional, numbness, feeling "slow", feeling "foggy", difficulty concentrating, difficulty remembering, and visual problems.[6] This questionnaire lists many possible symptoms, however, it does not mean each individual will be experiencing each of them. Depending on the mechanism of injury, a patient may also experience cervicogenic pain due to sustaining a whiplash injury. The Post-Concussion Symptom Scale was not administered in this particular patient case, but the subject of this case report was experiencing a number of the listed symptoms.

Recent literature involving a prospective study in the emergency room identifies the following symptoms as risk factors for developing PCS: an alteration of consciousness following the head injury, a headache right after the injury, or alcohol consumption prior to the injury.[4] Though these have been identified as risk factors, it is not the end all be all, and there is still plenty of questions as to why some patients experience prolonged symptoms and PCS. No matter the reasoning, the symptoms can cause a great amount of discomfort and can be life altering.

The literature describing the evaluation of a patient experiencing prolonged symptoms following a mTBI includes tests and measures to evaluate the patient's vestibular and ocular motor systems as well as the patient's overall balance. Elbin et al. administered the VOMS to a group of patients following a mTBI, and concluded that each participant displayed impairments on every component of the exam within the first 7 days of a mTBI. All but two of these impairments resolved within 14 days following the mTBI, indicating that these impairments typically resolve independently.[3] In patients with post concussive syndrome these deficits persist. Aside from vestibular and ocular motor deficits, the patient's balance system and their vestibular system's function in postural control can display deficits following a mTBI. Massingale et. al**.** administered the concussion balance test (COBALT) to 132 uninjured athletes and 1056 injured athletes to assess their performance with balance tasks.[5] They found that all of the uninjured athletes tested were able to complete the entire COBALT balance screen, compared to only 55% of injured athletes. This study concluded that athletes who have experienced a recent concussion also committed a greater amount of errors and displayed increase center of mass sway throughout the COBALT testing screen.

There are multiple facets of the treatment techniques for symptom relief in patients experiencing PCS. One treatment found to provide symptom relief and improve function is Head-Eye Vestibular Motion Therapy (HEVM). In a group of 70 patients ranging in age from 14 to 47 they performed HEVM therapy for 5 days, concluding that HEVM therapy significantly reduced the patient's experienced symptoms related to chronic PCS.[1] Tsaousides et. al. studied the relationship between employment status and quality of life (QOL) and depression.[7] They included 317 individuals with self-reported TBIs and they found only about 1 out of every 5 individuals returned to work at the same level as prior to their mTBI. They concluded that employment status had a significant correlation with an individual's QOL, and a decrease in employment level increased the risk for QOL reduction and depressive symptoms. This indicates that when treating these patients, assessing their desire to work is important, as well as tailoring therapy towards a return to work.

There have been some studies indicating a specific intervention may alleviate some of the symptoms experienced by a patient with PCS, but there is limited research outlining the progressions of these interventions. As we continue to learn more about PCS, the proper progression of a patient through physical therapy becomes unclear. The purpose of this case study is to provide the audience with examples of interventions and progressions used to treat a patient experiencing symptoms related to PCS following a mTBI.

Case Description

The patient was a 55 year-old male Emergency Medical Technician (EMT) who suffered a mTBI following a tractor accident 2 weeks prior to his first appointment. The patient was referred to Physical Therapy by a Sports Medicine Physician who diagnosed him with mTBI, without loss of consciousness; concussion, without loss of consciousness; postural instability; functional vision problem; and muscle pain. The patient reported he has experienced chronic headaches for several years, but they have been constant and more severe since the accident. He also reports that he has been having a lot of trouble with becoming easily frustrated, and states that this significantly increases his headache and ability to think clearly. He denies any sensation of dizziness, but reports feeling "off balance" and feels as if the room is spinning at times. He experienced an increase in symptoms when he tries to focus on reading a book. He also reported an increase in difficulty with walking and stair negotiation, feeling "off balance" and "uncoordinated in my legs", as well as weak. He reports that he initially was able to sleep uninterrupted, but is now having difficulty, only sleeping a total of ~4 hours a night. He is also experiencing an increase in low back, neck, and left leg pain, as well as occasional left upper extremity numbness and paresthesia. The patient's past medical history is extensive including a history of 4 diagnosed mTBI with unknown dates, chronic headaches, chronic neck pain with a disk degeneration resulting in a fusion at C5-C6, a right rotator cuff repair. In addition, he was dealing with kidney stones on the day of the evaluation.

The patient lives at home with his wife and daughter, and works full time as an EMT. He reports prior to the accident he worked 24 hours on, followed by 48 hours off. He is no longer able to work with the recent increase in symptoms. The patient and his family state their main goals are to resolve his recent increase in headache and balance issues so that he can return to work and his previous daily life.

Examination and Evaluation

The patient did not complete any intake questionnaires upon arrival, so all of the information prior to the objective examination was derived from the subjective history as well as the physician's referral note. The patients' symptoms had not resolved after 12 days' time, which is atypical of the majority of diagnosed concussions or mTBI's.

Following the subjective questioning, the patient's cervical spine was tested in order to rule out any abnormalities or instabilities. The patient was experiencing stiffness bilaterally with rotation, but no objective measures were taken due to the patient having the available range to conduct the necessary objective examinations. The evaluating therapist found the alar ligament to be intact, sharp-purser sign to be negative, and the VBI to be negative bilaterally, deeming the cervical spine clear and safe for all vestibular and visual tests to ensue. After the cervical spine was cleared, an in depth vestibular evaluation was conducted to assess for vestibular deficits. The main goals of the objective examination included identifying deficits to tailor future interventions, as well as identifying either a central or peripheral vestibular deficit or dysfunction.

Table 1 outlines the battery of tests used to identify these deficits. Many of the objective tests administered were pulled from the Vestibular/Ocular Motor Screening test used to identify underlying deficits in patients following a brain injury.[3] The final objective test conducted by the evaluating therapist was the COBALT balance test. For the COBALT balance test observed errors included: loss of balance, lifting hands from iliac crest, opening eyes during closed eye trials, stepping or moving feet during trials, unable to keep up with the metronome beat (>than two in a row) (see Table 2).

The results of the initial evaluation indicated a complex picture of dysfunction, which is typical of a patient experiencing PCS. He presents with bilateral vestibular dysfunction of central origin, which is contributing to his impaired balance, dynamic instability, and difficulty with gaze stability found throughout the initial evaluation and results in his experienced symptoms.

Table 1: Initial evaluation summary of objective tests and findings.

Objective Test	Result	What does this test?	Reason For Test Selection
Smooth Pursuits	Severe nausea in all 8 directions, patient reported decreased clarity of target in lower right quadrant, as well as tracking downward.	Oculomotor tract dysfunction	The patient reported difficulty reading.
Spontaneous Nystagmus	Negative	Positive Test indicates Acute UVL or a central vestibular dysfunction	To help determine whether symptoms are due to vestibular dysfunction of vision impairment.
Gaze Holding Nystagmus- 30° off center in all 8 directions	Negative in all directions		To help determine whether symptoms are due to vestibular dysfunction of vision impairment.
Saccades Vertically	Unable to be tested	Oculomotor tract dysfunction	Unable to be tested do to time constraints.
Saccades Horizontally	Unable to be tested	Oculomotor tract dysfunction	Unable to be tested due to time constraints.
Near Point of Convergence	>24 cm, normal convergence is <6 cm	Tests for cranial nerve palsies, malalignments or central pathway dysfunctions impairing oculomotor control into convergence	Patient reported visual deficits, as well as difficulty reading a book.
Cover Test	WNL	Ocular Alignment	Tease out visual impairments from vestibular deficits or dysfunctions
Cross Cover Test	WNL	Ocular Alignment	Tease out visual impairments from vestibular deficits or dysfunctions
Maddox Rod Test	WNL	Ocular Alignment	Tease out visual impairments from vestibular deficits or dysfunctions
Slow VOR Test	Abnormal with patient allowing eyes to lag off of target bilaterally, along with severe nausea during testing in both vertical and horizontal directions.	Gaze stabilization	To help determine whether symptoms are due to vestibular dysfunction of vision impairment.
Hallpike-Dix Right and Left	Negative bilaterally	BPPV	Patient reported sensation of the room spinning with direction changes
Horizontal Canal Roll Test - Right and Left	Negative bilaterally	BPPV	Patient reported sensation of the room spinning with direction changes
Head Impulse Test (Head Thrust)	Mild lag toward left initially, but was deemed negative bilaterally upon a couple repetitions.	Gaze stabilization, unilateral or central vestibular dysfunction.	To help determine whether symptoms are due to vestibular dysfunction or vision impairment.

Table 2: Initial evaluation summary COBALT Balance test. All tests were completed with feet together, except head shake nystagmus where feet were placed shoulder width apart.

Condition	Time	Errors Committed	Observed Results
Condition 1: Eyes Open, Firm Surface:	20/20 sec	0 errors	--
Condition 2: Eyes Closed, Firm Surface:	20/20 sec	0 errors	Significantly increased sway (Severe). Increased dizziness.
Condition 3: Eyes closed, Firm surface, Head Shake: *120 bpm, 1 head turn per beat*	5/20 sec	2 errors	Unable to keep up with metronome; Loss of balance (stepped feet apart). Severe increase in HA/Dizziness/Frustration.
Condition 4: Visual Motion Sensitivity (VOR Cancellation), Firm surface: *40 bpm, 1 rotation per beat*	20/20 sec	0 errors	Significant increase in sway. No change in dizziness. HA increases, as patient becomes visibly frustrated. HA increased to 8/10 after these tests, so foam activities deferred.
Condition 5: Eyes Open, Foam Surface:	Unable	--	--
Condition 6: Eye Closed, Foam Surface:	Unable	--	--
Condition 7: Eyes Closed, Foam Surface, Head Shake:	Unable	--	--
Condition 8: Visual Motion Sensitivity (VOR Cancellation), Foam surface:	Unable	--	--

Interventions Overview

The patient received 14 physical therapy sessions over an 8-week period. Along with receiving physical therapy treatment, the patient also received treatment from a Speech Language Pathologist two times a week for cognitive training and improved executive function. Previous literature has indicated that improved executive function can improve a patient's mobility following a concussion.[2] The patient's entire episode of care was overseen by a Sports Medicine Physician, specializing in mTBI and post-concussive syndrome for medical management. In addition, he received a couple bouts of "Battle Field Acupuncture" from his physician to help manage his constant headaches. The treatment team for this patient conversed regularly, and adjusted treatments based on the feedback of each discipline.

The physical therapy interventions for PCS could be grouped into four treatment categories: vestibular interventions, balance interventions, manual therapy and strengthening exercises for postural improvements, and work simulation tasks. Throughout the entire episode of care, the patient's pain levels were monitored and recorded on a self-reported 0-10 pain scale, rating his perceived pain in categories including headache severity and cervicogenic pain. His perceived dizziness and nausea were monitored with a patient reported 0-10 scale as well. The most important characteristic used to evaluate patient tolerance and progress interventions was the perceived change in symptoms following an intervention. A change in self-reported pain rating greater than 2 points out of 10 was considered meaningful, and rest was provided to allow a return to baseline pain if possible. Thus, interventions were progressed more so based on changes in reported pain levels, than the initial reported pain levels prior to therapy.

Vestibular Interventions

The vestibular interventions were targeted to improve the deficits found in the examination indicating central vestibular dysfunction. The majority of the interventions included head-eye vestibular therapy, which was previously found to be successful in reduction of symptoms in PCS.[1] The vestibular

therapy interventions included VOR1 as described in figure 1, Head-Eye Movement as described by Susan B. Herdman, PT, PhD, and the Dynavision (figure 2). Progressions used for each intervention are listed below.

VOR1 and Head Eye Movement exercises were initiated in the seated position with a card held in front of a blank background. To progress each of these exercises either their position, surface beneath them, or background behind the cards could be modified. These exercises were progress from the seated position to standing, standing on an uneven surface, such as a foam pad or wobble board, ambulating down the hallway, or ambulating on a treadmill. The background behind the card was progressed from a blank white wall to a picture on the TV screen (kaleidoscope), congestion in the hallway, moving outdoor environment through the window in front of the treadmill, or a moving image on a TV screen such as a moving Kaleidoscope, GoPro footage of BMX bikers in the city, and police lights. The final progression for these exercises was the addition of a cognitive task provided by the Speech Language Pathologist.

Figure 1: Example of the VOR1 vestibular therapy exercise. The patient first looks straight forward with their gaze fixed on the target, they then rotate their head side to side while keeping their gaze fixed on the target.

The final intervention used for the vestibular therapy category was the Dynavision **(**Dynavision International LLC, West Chester, OH**)**. The Dynavision is a "light board" as shown in figure 2. This is used to challenge the patient's reaction time and visual scanning ability. The Dynavision was initiated on the 11th PT visit, starting with 4 minutes, with the patient standing on the ground with his feet hip-distance apart in front of the Dynavision. The Dynavision intervention was gradually progressed at subsequent visits to further challenge the patient by standing on an uneven surface, such as a foam pad or wobble board, and adding flashing numbers in the center of the Dynavision for a set time and asking the patient to state the numbers aloud. Another progression used included throwing a light ball back and forth from either the patient's right or left side. This required the patient to use his peripheral vision and motor coordination to catch the ball, while still scanning the Dynavision for the next flashing light. The final progression included the addition of the same cognitive tasks provided by the Speech Language Pathologist as stated above.

Figure 2: The Dynavision light board used for this intervention.

Balance Interventions

Throughout his episode of care, the patient participated in many static and dynamic balance activities, including some upper and lower extremity coordination activities. The static balance activities were initiated on a firm surface with his feet apart and progressed first by moving his feet together into

Romberg position, and then adding an unstable surface beneath his feet. The static balance activities included horizontal and vertical head turns with his eyes open, then closed, as well as whole body rotational movements while standing in place. When the patient achieved good stability with the previously mentioned tasks on an unstable surface, the patient began to play catch using a light plastic ball with the therapist to improve balance as well as coordination.

The dynamic balance activities administered for this patient included many of the same concepts as the static balance activities, but were performed while walking down a hallway. Some examples include: ambulating with head turns, ambulating with his eyes closed, ambulating while playing catch with a ball, and lateral shuffles rolling a ball back and forth with the therapist, lateral shuffles with the ball while reading letters off the HART chart (rows and columns of a random assortment of letters, often used for vision therapy) placed on the wall on either side of the patient. The difficulty of these tasks was further increased when tolerated well by adding the same cognitive tasks mentioned above. These are examples of the balance activities utilized in this case report, but there are countless options to be utilized to challenge a patient's balance as long as the patient's response and change in symptoms is monitored closely.

Another aspect of the balance interventions administered included a variety of coordination exercises. One of the main concerns consistently brought to the therapist's attention by the patient at the beginning of each therapy session was the patients perceived incoordination of his lower extremities. We began with simple exercises such as lateral line hops, scissor jumps, and jumping jacks. He demonstrated significant difficulty and inability to complete these tasks. For external cues to improve his coordination, a metronome was utilized. The metronome was initially set at the lowest setting where the patient was able to maintain form and experience a minimal increase in symptoms. For this particular patient the metronome was initially set at 80 bpm and progressed as tolerated. Across several therapy sessions he was able to maintain form and demonstrate improved lower extremity coordination to metronome beats as high as 130 bpm. Other interventions utilized to target his lower extremity coordination included: foot taps on a chair, ascending and descending stairs, anterior/posterior line hops, lateral shuffles, karaoke, high knees, and glute kicks. In addition to the lower extremity coordination exercises, the patient's upper extremity fine motor control was challenged with a variety of card sorting activities. These activities were progressed by adding an unstable surface beneath the patient while standing or asking him to complete a cognitive task simultaneously.

Postural Interventions

This category included both manual therapy and postural muscle strengthening interventions, with the goal of reducing his experienced headache that may be due to muscular tension, as well as reducing his reported cervical stiffness. Initially, treatment focused on manual therapy to accomplish these goals. As his symptoms began to resolve, the focus shifted to postural muscle strengthening exercises with the goal of achieving longer lasting effects. The postural strengthening exercises utilized in this particular case included a variety of resistance band exercises, such as rows, horizontal abduction, shoulder extension, and D2 shoulder extension. The emphasis of each of these exercises was scapular retraction and improved upright postural control. About 4 weeks into his 8-week PT episode of care, the patient was provided a resistance band to complete these exercises as part of a home exercise program. The goal was to further advance benefits from these exercises as well as to continue to increase his activity tolerance outside of the therapy sessions.

Work Simulation Interventions

Previous literature indicates QOL and depression following a brain injury can be greatly affected by their ability to work**.**[7] In the same study, the authors concluded it is important to be aware of the person's desire to work and perceived importance of work. Due to this we did not push the return to work activities initially until the patient voiced a desire himself. Upon beginning the 6th therapy session in the 3rd week of his 8-week PT episode of care, he indicated he would like to return to work when his symptoms were manageable. We had him bring in a list of his job requirements as an EMT and

adjusted treatment to simulate these requirements. This included adjusting the interventions in the other treatment categories, for example, using flashing “police lights” as the background of the VOR1 exercises to simulate the lights of the ambulance. Other examples included lifting boxes from the ground and sled pushes to simulate lifting spine boards and moving hospital beds. Other variations included increasing the number of activities requiring increased cognition and multi-tasking ability, so that he would be able to think quickly on his feet when he was out in the field as an EMT. Not all cases will include a patient of the same job requirements, but there are variations to the aforementioned interventions that can be made to tailored to meet the requirements of any job.

Outcome Measures

The patient demonstrated resolution of his pain as well as reduced dizziness, improved activity tolerance, and improved coordination and balance following 8 weeks of physical therapy. His average pain rating decreased from an average of 6/10 on the first therapy session to 0/10 on the final therapy visit. He was also able to return to work after 8 weeks of physical therapy, but we planned to continue to see the patient for a couple more visits to ensure a trouble free transition to full time work duties. However, as he successfully returned to work he did not return for his final appointments, thus we were unable to repeat all of the intake tests and measures, including the vestibular exam and the COBALT balance exam. However, he demonstrated improved balance through the balance intervention progressions. Even without the outcome measures being completed prior to discharge, the large reduction in experienced symptoms and the patient’s return to work without complications are measures of success.

Discussion

The purpose of this case report was to provide an example of interventions and progressions used to treat a single patient experiencing symptoms related to PCS following a mTBI. The treatment of this particular patient case included physical therapy and speech therapy, all while being under the care of a Sport’s Medicine physician specializing in PCS management. The physical therapy targeted the apparent deficits in his vestibular and balance systems, as well as impaired posture, increased cervical stiffness, and decreased overall function resulting in being unable to work. The therapy included a variety progressions of head-eye vestibular therapy treatments, balance exercises, postural training, and return to work activities.

Previous literature indicated that head-eye vestibular motion therapy had resulted in a reduction in symptoms experienced by a large group of 70 patients experiencing symptoms relate to PCS.[1] Following treatment, he experienced a large reduction in experienced symptoms, suggesting results in agreeance to the previous literature. Additional research demonstrated a correlation with a patient’s ability to return to work and their improved QOL.[7] Though the QOL was not directly measured in this particular case, the patient’s perceived pain ratings began to decrease as return to work activities were initiated, and when symptoms allowed him to return to work he did not experience an increase in experienced symptoms even with an increase in functional activities. This demonstrates correlation between his ability to return to his previous level of work and a reduction in symptoms, and possible improvement in QOL as concluded in the aforementioned study. Prior literature had also indicated that the scores on the COBALT were lower when performed by patients who had experienced a recent mTBI.[5] This particular patient demonstrated significant impairments when completing the COBALT, but no baseline measure was taken prior to the mTBI or at the end of the episode of care to either confirm or deny the relationship of the mTBI and the results on the COBALT in this particular patient.

Though the results of this study indicated positive results in terms of symptoms reduction and a significant increase in function indicated by a return to previous level of employment, future research could be done to examine the success of these intervention progressions over a large variety of patients. In addition, one short-coming in the literature in regards to the research done on the deficits on the COBALT is that it is examined in young athletes. This makes it hard to generalize to a large variety of patients suffering of symptoms related to PCS.

The purpose of this case study is to provide the audience with examples of interventions and progressions used to treat a patient experiencing symptoms related to PCS following a mTBI. This purpose is met by providing a list of the interventions and progressions used to resolve this patient's symptoms, as well as describing the use of the patient's perceived pain rating to guide the progressions of treatment. Aside from the treatment progressions, this case report also provides an example of the objective tests and measures used to diagnose a patient with a central vestibular dysfunction following a mTBI.

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