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Vestibular Rehabilitation And Cervical Postural Re-education In A Young Athlete Who Presented With Post-Concussion Syndrome: A Case Report

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The patient and the patient's guardian signed an informed consent allowing the use of medical information and video footage 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 and Purpose:

Current literature on Post-Concussion Syndrome (PCS) rehabilitation is limited. Current literature is focused on individuals experiencing military blast traumatic brain injuries and the management of these injuries. Thus, the purpose of this case report is to describe and implement PT management and outcomes for the young athlete presenting with PCS following a concussion.

Case Description:

The patient was a 14 year old male who presented to the outpatient clinic with significant impairments secondary to diagnosis of PCS. Impairments that the patient presented with were activity intolerance, increased muscle tone, headaches, and dizziness. The patient underwent manual therapy treatment consisting of soft tissue mobilizations to the cervical musculature and postural corrections, as well as, a vestibular ocular reflex (VOR) habituation program. These interventions were utilized to increase the patient's tolerance to his surroundings and to return the patient to his prior level of function.

Outcomes:

The patient was treated for 9 visits over a 5-week period. With manual treatment and VOR habituation exercises, improvements were seen with increased pain-free ranges of cervical motion and improved activity tolerance as demonstrated by the Dizziness Handicap Inventory (intake: 46, discharge: 4) , the Post-Concussion Syndrome Inventory (intake: 64, discharge: 7), and the Balke treadmill protocol (intake: 110 bpm, discharge: 187 bpm).

Discussion:

This case report describes the clinical reasoning and clinical usage of the combination of cervical manual therapy and VOR habituation exercises in a patient with PCS. This case report

suggests that these interventions may be beneficial to improve activity tolerance and help a patient return to their prior level of function.

Word Count: 262

Background/Purpose:

The prevalence and the proper management of sport-related concussions is a rising topic in the sports medicine field. As defined by Abrahams et al, a concussion is a pathophysiological process resulting in functional neurological impairments as a consequence of forceful impact directly on or transmitted to the head, neck, or face[1]. Approximately 300,000 concussions occur to high school athletes in the United States, making sports second to motor vehicle crashes as the leading cause of concussions[2]. A concussion can result in mental, cognitive, and behavioral side effects that can be present usually up to 10 days following injury. In result of this head injury, the most commonly noted symptoms are: headaches, fatigue, dizziness, and difficulty concentrating.

Risk factors for a concussion have been extensively studied. According to a systematic review on risk factors for concussions, previous concussion history, gender, and type of sport are the most prevalent risk factors[1]. In the same study, it was found that an athlete who had a previous concussion was at a 2 to 11 times more likely to sustaining another concussion. Research is inconclusive on which gender is more susceptible to concussions; however, studies can conclude different sports put males and females at different risks. Thus, males are at more of an increased risk for concussions during alpine sports, football, and lacrosse and females are at more of an increased risk for concussions during soccer, basketball, and softball. Noting the increased rate for male lacrosse athletes, the patient that will be presented in this case study was side-lined with a concussion obtained during lacrosse practice.

As stated previously, concussion side effects can last up to 10 days following the injury. When side effects that are persistent past 10 days, a person is consisted to have PCS. About 10% of people will develop signs and symptoms of PCS following a concussion[8]. Given the prevalence and knowledge of diagnosing a concussion in an athlete, there is a lack of research on the epidemiology, the pathophysiology, and the management of PCS following the initial injury. Thus, the purpose of this case report is to outline and implement an appropriate option for physical therapy management that can be applied to the young athlete who obtains PCS secondary to a concussion.

Case Description- Patient History and Systems Review:

Patient history:

The patient is a 14 year old male who was referred to the orthopedic outpatient setting in June 2015 from an orthopedic physician. Prior to his initial evaluation, both the patient and his guardian signed all consent to treat paperwork. Upon the history intake, it was discovered that he sustained a head injury during lacrosse practice about one month prior to this initial evaluation. The mechanism of injury was described as another athlete swinging the lacrosse stick around and making contact with the patient's head. The patient was able to continue practice, but had increased headaches, dizziness, and blurred vision afterwards. As a result of continued symptoms, the patient sought medical attention. He has not had previous services related to this current episode.

Prior to this injury, the patient's mother notes that her son was a rather healthy individual who enjoyed being around his friends and being active in his high school athletics. Not only does he enjoy athletic events, but he also enjoys being outside participating in fishing and hiking. Following this injury, the patient's mother states that he tended to spend most of his time inside

and does not participate in any activities that he normally would. She believes her son has obtained more of a lethargic affect, as well as, a depressive demeanor. She reported that activities such as fishing and participating in athletics increases the patient's symptoms. The patient requires the use of NSAID's in order to manage his headaches throughout the day; however, no other medications are being taken at this time. Also, the patient's medical/surgical history was unremarkable. The patient/family goes for this related service are to return the patient to his prior level of function and sporting events symptom free. His mother would also like her son's psychometric factors, such as his mood behaviors and affect, return to baseline.

Systems review: Table 1

Cardiovascular	
Impaired	Reduced heart rate tolerance to exertion
Musculoskeletal	
Impaired	Restricted range of motion with all cervical motions
	Forward head and rounded shoulders
	Kyphotic posture
	Gross strength impairments in all cervical motions
Neuromuscular	
Impaired	Increased headaches
	Impaired balance in double limb and single limb stance
Integumentary	
Not impaired	
Communication	
Not impaired	
Affect, Cognition, Language, Learning style	
Impaired	Lethargic and depressed affect

Clinical Impression 1:

Following the subjective history and systems review intake, it was hypothesized that the patient had signs, symptoms, and mechanism of injury that are consistent with the referring diagnosis of PCS. A possible differential diagnosis to this case would be whiplash associated disorders (WAD). Additional tests and measures that will be conducted to confirm this diagnosis

include: functional balance testing, cervical range of motion, Balke protocol testing, administration of the Dizziness Handicap Inventory (DHI) and the Post-Concussion Syndrome Inventory (PCSI), special cervical tests and gross cervical muscle performance testing.

Due to increased impairments such as headaches, dizziness, sleep disturbances and blurred vision, this patient is unable to participate in his lacrosse season, summer basketball camps, or his outdoor activities he enjoys. His impairments create activity limitations with ADL's and IADL's such as daily chores around the house and being on the computer for school work due to activity intolerance. The patient continues to be an appropriate candidate for this case report due to the fact that literature is limited on a suitable physical therapy treatment plan for patients who present with PCS secondary a concussion.

Examination- Tests and Measures:

A standardized examination was performed on the patient and the findings are found in table 2.

Table 2

Tests & Measures	Initial Evaluation Results	Reliability/Validity
Observation		
Patient presented with a significant forward head and rounded shoulder presentation		No psychometric properties
Palpation		
Significant muscle guarding around posterior cervical musculature. Both superficial and deep cervical musculature was hypertonic		No psychometric properties
Right		
Erector Spinae	Wincing with Withdrawal	
Suboccipitals	Wincing with withdrawal	
Left		
Erector Spinae	Wincing with withdrawal	
Suboccipitals	Wincing with withdrawal	
Standardized Test		
Dizziness Handicap Inventory	46	
Post-Concussion Syndrome Inventory	64	Test-Retest Reliability: ICC= .65-.89[5]

		Validity: r= .8[5]
Balke Protocol HR ceiling	110 bpm	
Balance Error Scoring System	23	Test-Retest Reliability: ICC= .70[6] Intrarater Reliability: r= .63-.82[7]
Active Range of Motion		
Extension	100% and painful	No psychometric properties
Flexion	75% and painful	
Right		
Rotation	75% and painful	
Lateral Flexion	75% and painful	
Left		
Rotation	100% and painful	
Lateral Flexion	100% and painful	
Special Orthopedic Tests		
Right		No Psychometric properties
Alar Ligament Test	Negative	
Transverse Ligament Test	Negative	
Vertebral Artery Test	Negative	
Left		
Alar Ligament Test	Negative	
Transverse Ligament Test	Negative	
Vertebral Ligament Test	Negative	
Vestibular Tests		
Smooth Pursuits	Positive. Patient had difficulty with visual tracking with pursuits.	No Psychometric properties
Saccades	Positive	No Psychometric properties
VOR Head Thrust	Not tested at evaluation due to patient's tolerance and pain scales.	No Psychometric properties
Pain Scales		
Headache Pain Scales	Worst: 6/10	No Psychometric properties
	Best:4/10	

ICC= Intraclass correlation bpm= beats per minute HR= heart rate

Clinical Impression 2:

Evaluation

This patient is a 14 year old male who presented to the clinic following a head injury during an athletic event about a month ago. Following the examination and observation, it was apparent that his patient had clinical findings, signs, and symptoms that were consistent with the referring diagnosis of PCS. He presented with poor posture, impaired cervical strength and range of motion, poor soft tissue extensibility, increased number of headaches, impaired balance. When put through the Balke treadmill protocol, he demonstrated intolerance to exertion when symptoms were provoked within the first minute of starting this test. These symptoms have led to movement abnormalities as well as reduced participation in his athletic activities, social events with friends, and attending school. After scoring a 46/100 on the DHI and a 64/100 on the PCSI, one would be confident when confirming the original impression of this patient. The differential diagnosis of WAD can be ruled out because of both the mechanism of injury and the patient's reduced tolerance to activity during the Balke treadmill protocol.

Physical Therapy Diagnosis

Given this patient's mechanism of injury, prior history of this episode, and impairments, a primary diagnosis from the Guide to Physical Therapist Practice can be given. This diagnosis is impaired arousal, range of motion, and motor control associated with coma, near coma, or vegetative state. Due to the fact that this patient did not lose consciousness during this injury, the ICD-9 code that would correlate with this diagnosis would be 850.9 "concussion, unspecified."

Prognosis

The patient's prognosis can be classified as excellent if VOR habituation, balance training, and a progressed aerobic exercise program is put into place. He will benefit from skilled

PT 2 times per week for 4-6 weeks in order to reduce pain, resolve headaches, reduce symptoms, retrain balance and improve HR tolerance. Fatigue and reduced exercise capacity are symptoms following a concussion that can be contributed to the disruption of cerebral blood flow. According to Leddy et al, it was determined by functional MRI that with a controlled aerobic exercise treatment program, normal localized cerebral blood flow regulation will be restored[4]. The prognosis for my patient is excellent due to the fact that an aerobic exercise program will be initiated with him.

Not only is an aerobic program going to be initiated, but a vestibular rehabilitation will be used to reduce the patient's dizziness, light-headedness, and headaches. Alsalaheen et al found that people who had persistent dizziness and gait and balance dysfunction after a concussion had improvements in these areas following vestibular rehabilitation[4]. In this study, the authors used the DHI as an outcome measure pre-treatment as well as post-treatment. There was significant improvement in the dizziness that the patient reported during these outcome measures following the vestibular rehab. With this research, clinicians can be confident that patient's with this diagnosis have an excellent prognosis to return back to prior levels of function.

Plan of care

The patient was referred by an orthopedic physician. Unless the patient does not progress with physical therapy goals, he would not be referred out to another physician. In order to track progression, the patient completed the Balke Protocol once a week in order to monitor his HR tolerance to exertion. Also, he completed the DHI and the PCSI outcome measures. Following completion of all physical therapy goals stated below, the patient will be discharged to participate in school athletic events.

Table 3

Short Term Goals (3 weeks)	Long Term Goals (6 weeks)
Patient will increase HR tolerance from 110 to 150 beats per min during the Balke protocol in order to increase his tolerance to activities	Patient will increase HR tolerance from 150 beats per min to his age-predicted HR max during the Balke protocol in order to return him to his previous functional
Patient will improve from 46 to 23 on the DHI in order to increase tolerance to activities	Patient will obtain a score of 16 or less on the DHI in order to return him to his previous level of function
Patient will improve from 64 to 32 on the PCSI in order to increase participation in his athletics	Patient will obtain a 10 or less on the PCSI in order to return him to his previous level of function

Interventions

Coordination/communication/documentation

Communication to the patient's referring physician was initiated, as well as, coordination with his physician for follow-up appointments throughout the duration of the treatment. He will be referred back to the physician if any concerns arise or his prior level of function is not achieved. All pertinent documentation of treatment sessions will be faxed to his physician as well. Informed consent from the patient's mother to provide physical therapy to the patient was obtained. Coordination with the insurance provider will be initiated in order to know his coverage for these services and to know how many visits he is allotted.

Patient/client/family- related instruction

Patient education on pathology, signs, symptoms, functional limitations, impairments, participation restrictions as well as the risk factors for this diagnosis was explained to both the patient and his mother. They were both educated on the importance of physical therapy in order to return the patient to activities and the importance of compliance to a home exercise program. The frequency and duration was explained to the patient which was noted to be 2 visits per week

with an expected duration of 6 weeks. Both the patient and his mother were in agreement and understanding of all instructions that were provided for them.

Procedural interventions

Procedural interventions that were utilized include client education, home exercise program, joint mobilization techniques, neuromuscular re-education, proprioceptive/closed kinetic chain activities, soft tissue mobilization techniques, stretching/flexibility activities, and therapeutic exercise. Along with these procedural interventions, vestibular rehabilitation was used. These interventions include adaptation, balance training (dynamic and static balance), cognitive tasks, and habituation.

There is conflicting literature on the outcomes that neurocognitive rehabilitation for patients with mild traumatic brain injuries. According to Mittenburg et al, neurocognitive rehabilitation only showed effectiveness for severe brain injuries[9]. However, in another study, neurocognitive rehabilitation showed improvement in cognitive function in mild or mild-to-moderate brain injuries[10]. According to current research on PCS rehabilitation, emerging therapy for this diagnosis is using an increased graded activity as a standard procedure. Research suggests that the athlete with PCS performs graded stationary exercise attempting to reach a heart rate target of 85% of age-predicted heart rate[8]. As research suggests, a graded stationary exercise was attempted with the patient. Although recent research suggests that neurocognitive therapy has shown little effectiveness for mild traumatic brain injuries, the patient for this study partook in cognitive tasks during vestibular rehabilitation. The patient was scheduled for PT 2 times per week and were 60 minutes sessions. The procedural interventions are as followed.

Manual Therapy

According to research, manual therapy and exercise has been shown to be more effective than passive treatment modalities for patients with neck pain[14]. With this strong research to support manual therapy, the first sessions began with soft tissue mobilizations to sub-occipital and erector spinae musculature in order to address the impairments that were identified during the initial examination. Following soft tissue mobilization, grade 2 and 3 joint mobilizations were utilized in the area of the occiput-C1 segment in order to improve cervical range of motion (ROM). This was completed until the patient was able to achieve full AROM. Table 4 can be referenced for frequency and duration of this intervention.

Neuromuscular Re-education/ Therapeutic exercise

In order to address the patient's forward head and rounded shoulder posture, stabilization training was used throughout each session. The stabilization training consisted of theraband rows and pull downs, as well as, "no-monies." Theraband rows were completed by having the theraband hooked to the wall and the patient stood with the band on tension. He then completed a scapular retraction motion (figure 5). The same set up was used for the theraband pull downs; however, the patient maintained straight arms as he started in shoulder flexion and moved toward shoulder extension (figure 4). During "no-monies," the patient started with the theraband in his hands with supinated forearms. With keeping his elbows against his side and maintaining a chin tuck, he externally rotated his shoulders (figure 3). Patient compliance to maintain the chin tuck during the stabilization training was crucial in order to target the goal of re-training his posture. According to Hugentobler et al, postural re-education and manual therapy were contributed to the return of the athletes who had PCS following a concussion[15]. Specific interventions that were used in this study are as followed: scapular rows, chin tucks with various scapular/shoulder movements, planks, soft tissue mobilizations, and manual glides at C2. Similar to this case, these

interventions were completed with the anticipated goals to improve activation and control of appropriate postural musculature and to increase joint mobility, as well as, cervical ROM. With this research, one could link the significance of using the chosen interventions on a patient with the specific diagnosis of PCS

Another component of this patient's program was vestibular rehabilitation. This program consisted of habituation and adaptation by setting a cadence on a metronome[*]. The patient held a piece of paper with a number on it at arm's length and was asked to keep his eyes on that object while moving his head in side-to-side and then up/down motions. As he progressed in this program, he was challenging by placing the patient on an Airex foam[†] while during these motions to challenging his balance. When it was appropriate, he also instructed in the cognitive portion of the vestibular rehabilitation program. This consisted of walking in a toe-to-heel manner towards a mirror that had 3 numbers taped up while moving his head in the earlier described motions. He was then asked to complete a cognitive task such as: "name state capitals." The cognitive tasks were added in order to add distractions and allow the patient to adapt to the increased stimuli. The Balke protocol treadmill testing was completed one time per week in order to document improvements in the patient's HR tolerance. The Balke protocol can be found in the Appendix. For each intervention, the frequency, duration, and order will be outline in table 3.

Interventions that were used were listed in chronological order in order to provide this patient with a successful prognosis. During the initial examination, the Balke Protocol Treadmill test, the DHI, and the PCSI were administered in order to obtain baselines for these measures. Until the stated goals were achieved, these outcomes measures were administered to monitor

[*] Matrix MR-500 Quartz Metronome
[†] Ariex AG Industri Nord 26 CH-5643 Sins Switzerland

progression of symptoms. As one could see, manual therapy was used prior to postural correction interventions in order to achieve full cervical ROM and reduce hypertonicity in the patient's cervical musculature. Each session consisted of a vestibular rehabilitation component to provoke the patient's symptoms in order to habituate the patient to increased activities.

Changes that occurred during the plan of care were made to progress the patient as improvements occurred. Following the patient's fourth visit, soft tissue mobilizations and joint mobilizations were discontinued due to the fact that the patient was had decreased muscle tone and muscle guarding. He was also able to active full AROM; therefore, the manual treatments were no longer needed. Changes that occurred during the neuromuscular re-education interventions were increasing the resistance of theraband, as well as, increasing repetitions of the exercises in order to challenge the patient. During vestibular rehabilitation, changes were made to the cadence of the metronome, the surface the patient stood on, and the difficulty of the cognitive tasks. These changes were made in order to provoke the symptoms in hopes of increasing the patient's habituation to increased activity. Overall, the changes to the interventions were made if the patient was no longer challenged or the symptoms were not provoked in order to achieve the stated goals.

Table 4: Interventions

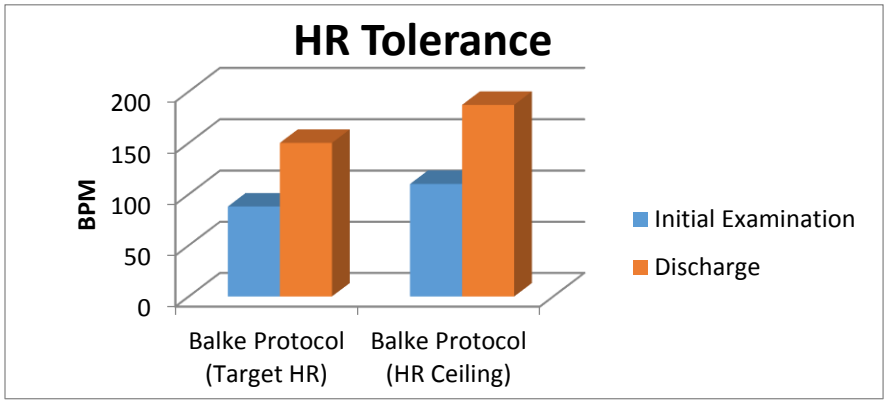
<table>
<tr><th colspan="9">Interventions</th></tr>
<tr><th><u>Session 1</u></th><th><u>Session 2</u></th><th><u>Session 3</u></th><th><u>Session 4</u></th><th><u>Session 5</u></th><th><u>Session 6</u></th><th><u>Session 7</u></th><th><u>Session 8</u></th><th><u>Session 9</u></th></tr>
<tr><td>Balke Treadmill
5 min</td><td>Joint Mobilization
3(10)</td><td>Balke Treadmill
5 min</td><td>Soft Tissue mobilization
10 min</td><td>Balke Treadmill
5 min</td><td>Tband rows- blue band
3(10)</td><td>Balke Treadmill
5 min</td><td>Tband rows- blue band
3(15)</td><td>Balke Treadmill
5 min</td></tr>
<tr><td>Patient education on symptoms, clinical findings, and return to sport</td><td>Soft tissue mobilization
15 min</td><td>Soft tissue mobilization
10 min</td><td>Chin tuck/head lift
3(10)</td><td>Tband rows- green band
3(15)</td><td>Tband pull downs- blue band
3(10)</td><td>Tband rows- blue band
3(10)</td><td>Tband pull downs- blue band
3(15)</td><td>Tband rows- black band
3(15)</td></tr>
<tr><td rowspan="5"></td><td rowspan="5">VOR Habituation- 3x side-to-side; 60 secs each
3x up/down; 60 secs each
Cadence: 100 bpm</td><td>Chin tuck/head lift
3(10)</td><td>Tband rows- green band
3(10)</td><td>Tband pull downs- green band
3(15)</td><td>“no-money”- blue band
3(10)</td><td>Tband pull downs- blue band
3(10)</td><td>“no-money”- blue band
3(15)</td><td>Tband pull downs- black band
3(15)</td></tr>
<tr><td>Tband pull downs- yellow band
3(10)</td><td>Tband pull downs- green band
3(10)</td><td>“no-money”- green band
3(15)</td><td rowspan="3">VOR Habituation Foam pad, Cognitive tasks initiated while walking
3x side-to-side; 60 secs each (standing and walking)
3x up/down; 60 secs each (standing and walking)
Cadence: 140 bpm.</td><td>“no-money”- blue band
3(10)</td><td rowspan="3">VOR Habituation Foam pad, Cognitive tasks initiated while walking
3x side-to-side; 60 secs each (standing and walking)
3x up/down; 60 secs each (standing and walking)
Cadence: 160 bpm</td><td>“no-money” black band
3(15)</td></tr>
<tr><td>“no-money”- yellow band
3(10)</td><td>“no-money”- green band
3(10)</td><td rowspan="2">VOR Habituation Foam pad, 3x side-to-side; 60 secs each (standing and walking)
3x up/down; 60 secs each (standing and walking)
Cadence: 130 bpm.</td><td rowspan="2">VOR Habituation Foam pad, Cognitive tasks initiated while walking
3x side-to-side; 60 secs each (standing and walking)
3x up/down; 60 secs each (standing and walking)
Cadence: 150 bpm</td><td rowspan="2">VOR Habituation Foam pad, Cognitive tasks initiated while walking
3x side-to-side; 60 secs each (standing and walking)
3x up/down; 60 secs each (standing and walking)
Cadence: 170 bpm</td></tr>
<tr><td>VOR Habituation- Foam pad, 3x side-to-side; 60 secs each
3x up/down; 60 secs each
Cadence: 110 bpm</td><td>VOR Habituation- Foam pad, Walking VOR initiated
3x side-to-side; 60 secs each (standing and walking)
3x up/down; 60 secs each (standing and walking)
Cadence: 120 bpm</td></tr>
</table>

( )= repetitions bpm= beats per minute

Outcomes

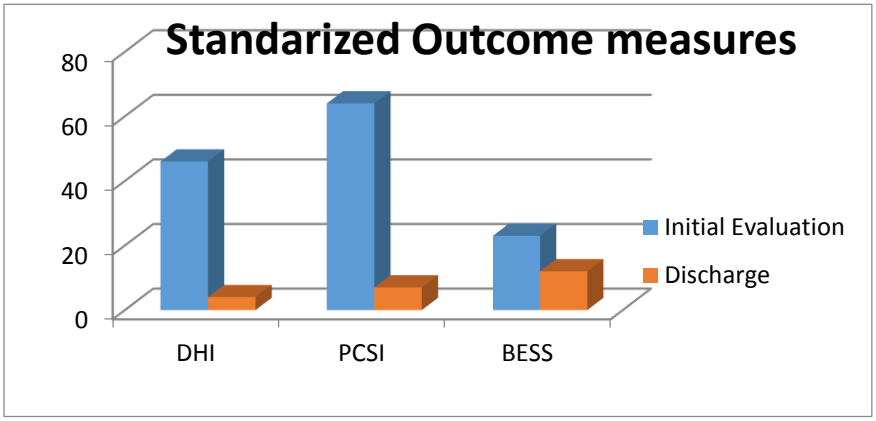
The patient was seen for 9 PT encounters over a 5 week duration. Gains that the patient established with PT were increased activity tolerance, improved cervical ROM, alleviation of headaches, reduced cervical muscle tone, and improved posture. During the duration of treatment for this patient, he was continuously monitored for improvements by use of an aerobic capacity fitness test (Balke Treadmill Protocol) and standardized outcome measures. The patient showed significant improvement in all areas when the initial examination results were compared to the discharge results. Results of these tests and measures and the outcome measures that were used for this specific patient can be found in figure 1, figure 2, and table 5. In figure 1, the Balke protocol was completed and shows the improvement in the patient's HR tolerance. At initial examination, the patient had a very low HR tolerance to activity before symptoms were produced. Since one could conclude less disability when there is a greater score, the patient showed improvement in his HR tolerance due to his HR being significantly greater at discharge rather than his HR at initial examination. Figure 2 shows the results from the DHI, PCSI, and the BESS. With these standardized outcome measures, greater the score means greater the disability. Therefore, one could conclude that the patient showed improvement from initial examination to discharge due to the lower numbers that were reported following discharge.

Figure 1



HR= Heart rate

Figure 2



DHI= Dizziness Handicap Inventory PCSI= Post-Concussion Syndrome Inventory BESS= Balance Error Scoring System

Table 5

Tests & Measures	Initial Evaluation Results	Discharge Results
Observation		
	Patient presented with a significant forward head and rounded shoulder presentation	Significant improvement in cervical posture
Palpation		
	Significant muscle guarding around posterior cervical musculature. Both superficial and deep cervical musculature was hypertonic	No muscle guarding occurred around posterior cervical musculature. Normal muscle tone was noted
Right		
Erector Spinae	Wincing with Withdrawal	No tenderness
Suboccipitals	Wincing with withdrawal	No tenderness
Left		
Erector Spinae	Wincing with withdrawal	No tenderness
Suboccipitals	Wincing with withdrawal	No tenderness
Active Range of Motion		
Extension	100% and painful	100% and non-painful
Flexion	75% and painful	100% and non-painful

Right		
Rotation	75% and painful	100% and non-painful
Lateral Flexion	75% and painful	100% and non-painful
Left		
Rotation	100% and painful	100% and non-painful
Lateral Flexion	100% and painful	100% and non-painful
Special Orthopedic Tests		
Right		
Alar Ligament Test	Negative	Negative
Transverse Ligament Test	Negative	Negative
Vertebral Artery Test	Negative	Negative
Left		
Alar Ligament Test	Negative	Negative
Transverse Ligament Test	Negative	Negative
Vertebral Ligament Test	Negative	Negative
Vestibular Tests		
Smooth Pursuits	Positive. Patient had difficulty with visual tracking with pursuits.	Negative
Saccades	Positive	Negative
VOR Head Thrust	Not tested at evaluation due to patient's tolerance and pain scales.	Negative
Pain Scales		
Headache Pain Scales	Worst: 6/10	1/10
	Best:4/10	0/10

Discussion

This case report is not only unique from the standpoint of a sports-related concussion causing PCS. What is unique is the fact that this patient presented with significantly poor cervical spine posture, as well as, cervical spine hypertonicity following a sports-related concussion. According to Schneider et al, cervical spine trauma may cause prolonged post-concussion headache[13]. By placing his head in a forward position for a prolonged period of time, lengthening of the posterior tissues resulted which could have been contributed to his prolonged headaches. Through cervical re-education and vestibular rehabilitation, the patient demonstrated clinical gains. These gains included: no longer had daily headaches, had improved cervical ROM and muscle tone, had significant improvement in HR tolerance and had an overall improvement in his attitude. Following discharge, the patient was able to demonstrate prior level of function and eventually was able to return to his sport activities. Positive factors that could have contributed to his success was family and friend support, determination level and fitness status prior to injury. Negative factors that could have inhibited or prolonged successful therapy could have been his depressed state of mind at initial examination due to losing his father prior to the injury. However, there were no standardized measurements used to quantify his depression levels.

In order to return an athlete who presents with PCS, cervico-vestibular rehab and attention to the patient's intolerance to activity is crucial, demonstrated by the randomized control trial by Schneider et al[13]. What was not specifically studied was the optimal length of treatment that it takes to return a patient back to activity. With that being said, further research is needed on not only the duration of treatment, but also what the optimal rehabilitation program is that will provide the opportunity to the return the athlete back to sport in the shortest duration of treatment sessions. Further treatment on the validity and reliability of the Balke protocol

treadmill test for PCS is needed, as research is directed more towards how the Balke treadmill protocol test pertains more to determining maximum oxygen consumption in an athlete.

Appendix

The Balke treadmill protocol was used in order to monitor and document progression in HR tolerance. The protocol is as follows[11]. Speed remains constant throughout the test; however, the grade of the treadmill increases 1% every minute. The test is terminated as soon as the patient's symptoms are provoked.

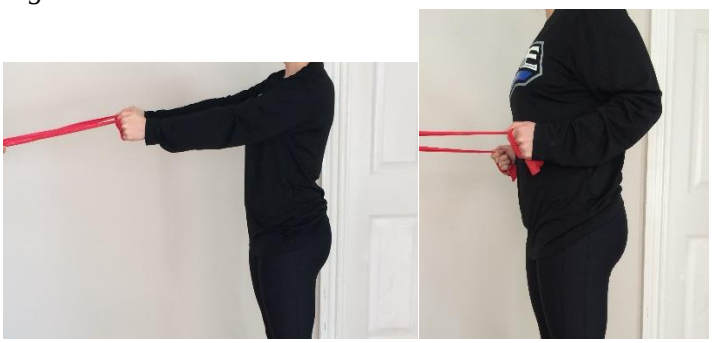
Table 6

Balke Treadmill Protocol Test		
Time(min)	**Speed (mph)**	**% Grade of Treadmill**
1	3.3	0
2	3.3	2
3	3.3	3

Figure 3: "No-Money" Shoulder Exercise

Figure 4: Theraband Pull-downs[12]

Figure 5: Theraband Rows[12]



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