Article ▸ The Peters/Price (See To Play) Vision Concussion Protocol: Diagnosis and Treatment

Michael Peters, OD, Raleigh, North Carolina
Jason Price, OD, Raleigh, North Carolina

ABSTRACT

Background: Sports-related concussion as a clinical entity has been a growing area of clinical concern. As primary eye care providers for the National Hockey League's Carolina Hurricanes, we have encountered these cases more and more each season. As a result, we have designed this retrospective study to assess our current evaluation and management protocols for all types of referred concussion cases.

Methods: All patients referred to our private practice clinic from 2011 through 2013 for evaluation of concussion were included in this study. Retrospective analysis was performed to determine number of cases with a visual component, change in refractive state, resolution via new glasses, those requiring vision therapy, and average time to return to play.

Results: A total of 137 patients were included in this study. Eighty-seven percent of patients (n = 120) demonstrated a visual component. Thirty-one percent (n = 37) of those resolved simply by changing their glasses prescription, while 61% (n = 73) required vision therapy to resolve their symptoms. Those who elected to perform vision therapy returned to play in less than six weeks' time, while those deferring vision therapy returned to play in more than double the amount of time (12.3 weeks).

Conclusion: The protocol studied is geared towards providing a uniform approach to diagnosing and treating concussions that demonstrate a visual component. The methods described not only accurately identify those with a visual component to their concussion but also provide an effective means of returning those individuals to play in a safe and timely manner.

Keywords: blurred vision, concussion, head injury, sports, vision exercises

As the optometrists for the National Hockey League's Carolina Hurricanes since 1997, we have witnessed firsthand the increase in concussions occurring in professional hockey. A recent analysis revealed that there were 44 concussions in the league in the 2009-2010 season, 65 in the 2010-2011 season, and 84 in the 2011-2012 season.[1]

Professional hockey seems to be trending with a national increase of sports-related concussions. The Centers for Disease Control (CDC) estimate that between 1.6 and 3.8 million concussions occur annually due to sports or other recreational activities.[2] These figures are on the rise over the past 10 years and have reached an epidemic level, according to the CDC. In fact, a recent study shows a 4.2-fold increase of concussions in high school sports in the last 11 years.[3]

David Tanabe was the first Carolina Hurricanes player forced to retire because of a concussion. This occurred as the result of a

hit he sustained during a game in December 2007.[4] A few weeks later, Matt Cullen sustained a concussion. His symptoms were mostly visual; he could not focus. Bright lights bothered him, and he could not stay on task. Riding in a car made his concussion symptoms increase. He was referred to a local optometrist who specialized in working with brain trauma patients. He became our first athlete diagnosed with visual dysfunction due to a concussion. Vision therapy was started. He was sidelined with this diagnosis until it was resolved.

As the team optometrists, we began to try to learn more about this diagnosis, prognosis, and treatment. We contacted the doctors involved in his case, as well as optometrists involved with rehabilitating this type of injury throughout the nation. There was consensus on the reality of this condition but no general consensus on prognosis and treatment.

As sports vision specialists, we were very versed in taking care of suppression, convergence issues, divergence, accommodation, and perceptual issues. However, we found it very hard to find out what type of specialized treatment was required for the concussed athlete, when the proper time was to intervene in the healing process, and whether elite athletes would require more specialized training than traditional patients.

Matt became more and more frustrated because his progress seemed stagnant. He asked for our help as well. We began treating his case by changing his contact lens prescription. Then we moved the vision exercises that he was using out of a clinical setting and into his sports environment. He also continued his vision therapy with the doctor who made the initial diagnosis and his home vision therapy activities until the visual component of his concussion resolved. He would later report to the local media after his recovery that vision therapy was important in his recovery.[5] He also felt that the DHA that he took in the form of omega-3 fish oils helped as well.[6]

In order to gain more knowledge about concussions with visual components, we attended the 2008 COVD Applied Concepts Course "Acquired Brain Injury" by Allen Cohen, OD. This is where we uncovered the foundation to our concussion treatment program. We took proven tests and techniques for diagnosing and treating traumatic brain injuries and began to develop a vision concussion protocol. Two tools from that seminar that we currently use are prescribing blue tint on eye glasses for photophobic patients and the rotational convergence test (stages 8 and 9 of our concussion protocol).

We began using a litany of tests and found that some were redundant or not required in full detail. Here is a list of examples:

- Dynamic acuity: showed no benefit as a diagnostic or treatment tool
- Accommodative facility: When we tested facilities with +/- 2.00 flippers, they were usually reduced and returned to normal after resolution.
- Base in/Base out reserves: These are reduced on visually concussed athletes. Near point of convergence testing is adequate to define initial issues. We have found that the Vizual Edge computer program addresses this issue better as reserves become normal during the end of the rehabilitation process.
- Midline shift test: This test is redundant in our protocol because athletes with midline shift perform poorly in our prism pitch-and-catch testing. Initially, we measured for this in all our patients, but the shift was gone after patients were able to pass stages 6 & 7 of our protocol.
- Balls and Prism tests: We experimented with different size balls and found that juggling bean balls worked the best. We experimented with varying prism amounts and found that the use of large and small prism was not effective. Fifteen prism diopters worked best.

- King/Devick: This test has received national attention as a possible sideline concussion test, so we tried to incorporate it into our testing but found that, since many of our professional athletes were outside the normal age test range, it was less useful. Our preference is to use the Vizual Edge computer program.

These tests we found important and included in our protocol were:

- Ocular health exam
- Auto refracting and retinoscopy
- Pupil testing for afferent defects
- Refraction/Acuity
- Retinal photography
- Convergence near point testing at upward, straight ahead, and downward gaze (evaluating for A or V patterns)
- +/- 2.00 D flipper testing of accommodation
- Worth 4 Dot on projector screen: Many visually concussed revealed movement of shapes. (Hand held units weren't as effective because of tester's hand movements)
- Throwing and catching a soft ball with the use of prism glasses and balance boards
- Rotational convergence testing
- Vizual Edge computer testing

We started our concussion protocol for sports-related concussions only. We have since altered this to include non-sports related concussions in all patients regardless of age. These findings are included in the retrospective study below (Table 1). The take-home message is that the average time to return to play using vision therapy was 5.8 weeks v. 12.3 weeks when deferring vision therapy. Patients had to be diagnosed with a visual concussion by our protocol in the calendar years 2011-2013 and prescribed vision therapy, which they either followed to completion or refused completely. They also had to continue care with a medical doctor and be released for return to play by the end of 2013.

Table 1: 2011-13 Peters/Price (See To Play) Concussion Protocol Results

	2011	2012	2013	2011-2013
Referrals to clinic	25	51	61	137
Visual component	24 (96%)	45 (88%)	51 (84%)	120 (87%)
No visual component	1 (4%)	6 (12%)	10 (16%)	17 (12%)
Refractive changes	20 (83%)	40 (89%)	33 (65%)	93 (78%)
Resolved with glasses only	7 (29%)	12 (27%)	18 (35%)	37 (31%)
Vision Therapy	16 (67%)	29 (64%)	28 (55%)	73 (61%)
Elected no vision therapy	1 (4%)	4 (9%)	5 (10%)	10 (8%)
Average weeks of vision therapy	4.5 weeks	4.5 weeks	4.5 weeks	4.5 weeks
Average office visits to eye doctor	2.96	2.63	2.22	2.8

Significant findings in patients diagnosed with visual dysfunction secondary to their concussion were:

- 78% required change in prescription
- 31% resolved spontaneously with only prescription change
- 61% used vision therapy
- 8% elected no vision therapy
- Patients using vision therapy resolved in 5.8 weeks versus 12.3 weeks for those who deferred vision therapy

Peters/Price (See To Play) Concussion Protocol:

The goal of the following program is for a patient to complete all 10 stages without developing concussion-like symptoms, which may include dizziness, light-headedness, headaches, motion sickness, fatigue, blurred vision, or nausea. Twelve percent of concussed athletes that we tested on their initial visit were able to pass all 10 stages, indicating no visual dysfunction secondary to their concussion. For patients who report that they are asymptomatic before testing (have no concussion symptoms), we stop testing when patients indicate that they feel a return to concussion-like symptoms, indicating an underlying visual dysfunction.

Patients who have concussion symptoms upon arrival for their first office visit, or any of their subsequent office visits, are asked to rank their presenting concussion symptoms on a scale of 0-10 (0 represents asymptomatic and 10 the most severe symptoms they have felt since the injury). We stop testing when patients report that their symptoms have increased by a ranking of 2 levels. We have found that concussed patients without a visual dysfunction or concussed patients with resolved visual dysfunctions can pass all 10 stages of this protocol without their concussion symptoms increasing.

The Protocol:

Stage 1: Ocular Health, Refraction, and Binocular Function

Stage 1 is only performed during the first patient evaluation. Complete history of injury, history of symptoms, and history of medical treatment is recorded. Ocular health is tested and documented. We may perform a dilated fundus exam after the protocol testing if we suspect a retinal detachment. In general, we avoid the use of mydriatics because we do not want possibly to increase concussion symptoms. We feel that we get adequate evaluation of the fundus by performing retinal photography, and we have observed that the flash can aid in our concussion testing by eliciting photophobic symptoms.

Refractive status: Autorefraction, retinoscopy, and manifest refraction are performed. We have found that retinoscopy is very important to perform because it can detect greater amounts of plus. We have found that cycloplegic refractions are not beneficial to the final prescription, and the side effects of the drops exacerbate concussion symptoms.

In our retrospective study, 78% of our patients with a visual component to their concussion had a change in refractive status. The prescription is changed when the hyperopic/cylinder shift is +0.50 / -0.25 or greater or if there is a myopic/cylinder shift of -0.25 / -0.50 or greater. Our preference is to prescribe a second pair of reading glasses instead of bifocals for our athletes who are trying to complete classroom assignments while their accommodative issues are resolving. This approach is also used with presbyopic patients who have not yet used a bifocal or multifocal. For those patients wearing progressive lenses, we try to switch them to a lined bifocal since progressives seem to exacerbate vestibular issues.

We have found that the entire visual component in 31% of our concussed patients will spontaneously resolve by simply having them wear their new prescription in glasses or contact lenses. In the instances where patients feel symptomatic when first starting out with their new prescriptions, they should slowly build up their wearing time until they can tolerate full-time use. We also recommend adding a 40% full blue tint with anti-glare to the glasses of patients who are very photophobic.

We try to avoid prescribing prism in spectacles. Most athletes' goals are to return to play as soon as possible. In the early stages of developing our protocol, we would prescribe prism in eyeglasses. The majority of these athletes would take off their glasses when allowed to return to light physical activity. Their visual systems would become confused, concussion symptoms would increase, and this would seemingly prolong their recovery. Therefore, we try to begin vision therapy as soon as possible to address diplopic concerns. For athletes with severe diplopia, it is recommended to stay shut down in a dark room until they can begin to move around with more ease. (One note: we would prescribe prism if this injury became a long term recovery or a permanent nerve or muscle injury.)

The second part of Stage 1 is to determine binocular function. Concussions with a visual component usually present with an anomaly in one or more of the following areas: convergence/

divergence, accommodation, or perceptual/cognitive. These issues are addressed with the following tests and should be performed with the patient wearing their prescribed corrective lenses.

1. Pursuits and Saccades: Smooth binocular eye movements are expected during this testing. We grade this as normal or diminished. Patients with a visual component to their concussion usually show jerky and erratic eye movement and have the tendency to over- or undershoot their targets on saccades (which is why this test is a popular sideline test by physicians).
2. Near point of convergence test: We have the patient stare at the tip of a pencil as we move it towards their nose from a starting position 20 inches out. This test is performed in straight ahead gaze, upward gaze, and lower gaze. Many patients with visual concussions exhibit convergence insufficiency, which is uncovered by this test. Also, many visually concussed patients will report lightheadedness, feeling funny, or dizziness when performing this test.
3. Cover Test
4. Accommodative rock: While looking at a near point acuity chart the patient should be able to pass a +/-2.00 flipper test for one minute without becoming symptomatic.
5. Worth 4 Dot: While wearing corrective lenses, the patient fixates through red/green glasses at the Worth 4 Dot pattern projected on the distance acuity chart. The patient should fixate on the binocular image and report that all objects on the pattern are present and devoid of movement. Movement of the image is usually defined by the patient as a shake or shimmer of any of the objects other than the fixation target. Patients should be asked specifically, "While looking at the white circle, do the green plus signs seem to shake or shimmer, does the red diamond seem to shake or shimmer, or do all four images seem to be equally still?" We have found this to be an important and sensitive test when projected from an exam room acuity chart. Hand-held testing is less reliable because the tester's hand movement may cause a shaking of images confusing to the patient.

We continue the testing to Stage 2 unless the patient reports an increase in concussion symptoms from Stage 1 testing.

Stages 2–9 are performed by our para-optometric technician and recorded on our test result sheets.

Stages 2–7 require the examiner to engage in activities of pitch and catch with the patient. We have found that we get better results when the testing is done in a hallway as opposed to a larger open space.

It is important that the examiner evaluate the patient's concussive symptoms before each stage and during the three minutes of testing in each stage. Before beginning the pitch-and-catch, the tester should always state: "It's important that you tell me if you start feeling funny or dizzy at any time, and we will stop the test. Earlier you stated that you symptom level was ranked at level X; please tell me if that level increases while we play pitch-and-catch."

The patient should also periodically be asked if they are experiencing a headache or other concussive symptoms. If so, then follow up with questions regarding the severity of the headache. A positive answer to these questions mandates halting any further visual testing, since we have effectively identified the patient's visual component of their concussion. Patients who report feeling distressed should immediately return to a dimly lit exam room to recuperate.

With the pitch-and-catch, the tester and patient should stand 15-20 feet apart. We

recommend using a bean bag ball similar to balls used by people learning to juggle. The ball should be thrown underhanded by both the patient and the tester. We have found that slow throws are the most effective, and the arc of the throw should be 3-4 feet higher (at most) than the height of the patient standing in a narrow hallway (4 feet wide), which is more effective than a room with large open space.

After 15 seconds from the start of each pitch/catch stage, the tester should start a dialogue with the patient asking questions such as: "How does this activity make you feel? Does this make you feel funny? Do you feel like you did after your concussion? Does this make you feel dizzy? Does this change the severity on your headache? How does the floor appear? Does the room look funny? Do the walls appear bowed or slanted?" The tester is watching and probing for any signs that concussion symptoms are returning or increasing.

Many athletes will be forthright and state when they begin to have problems, and at that point, testing should stopped. Any appearance of the room, walls, or floor moving or becoming increasingly distorted should alert the tester that the patient may be developing concussion related symptoms.

The tester should also throw the ball so that the patient will miss it from time to time. This is how we test and treat for vestibular issues that may be concurrent with visual issues. The patient has to bend down to pick up the ball and resume throwing. The up-and-down motion of the head, in combination with the changed perception of the patient's world, may cause the patient to become symptomatic. Any increased symptoms caused by bending over and picking up the ball should end the test.

Asking the patient simple questions about their recent day-to-day activities while playing pitch-and-catch increases the difficulty. We ask questions like: "How's the weather outside today?" "What have you been up to besides trying to get better?" "What's been going on at work/school?" (Of special note here, we have experimented with and found ineffective in this stage: playing overly loud music, having the patient shuffle side to side, having the patient jump, perturbation while catching and throwing, throwing faster and harder, using a longer distance between patient and tester.) Our observations are that patients find it easier to throw the balls faster. We have found that the protocol eliminates more false negatives when the throw is slow and steady while engaging patients in non-taxing, day-to-day conversations.

Some athletes are very motivated to return to play and may try to malinger. They will tell the tester that everything is normal when actually they are fighting through increasing symptoms. In most of these cases, patients will show physical signs and non-verbal clues of increased distress including sweating, facial flushing or pallor, change in facial expression, drastic mood, or demeanor change, and they may pitch forward or become confused when picking up a dropped ball. If a patient reports that they are asymptomatic but their body shows signs of distress, testing should be stopped, and the patient should return to a dimly lit room to recuperate. Mundane questions we ask these patients throw their concentration off so that it is harder for them to malinger.

One of our goals with the prism pitch/catch testing is to determine whether patients become symptomatic due to the presence of visual dysfunction secondary to their concussion. We experimented with varying prism powers and combinations of the base orientations to develop the testing that is most effective.

Stage 2: Dissociated prism on the ground

The patient wears prism glasses with 15 prism diopters base down (BD) OD and 15 prism diopters base in (BI) OS (Figure 1). The patient wears these prism glasses over their new post-concussion prescription when possible.

Figure 1: *NHL's Jay Harrison catching while wearing yoked prism glasses*

The tester starts a timer and holds a bean bag ball for the patient to fixate. The tester describes, "Right now, you probably see two of me and two balls. I want you to watch the top ball, and we are going to play a game of pitch-and-catch." The ball is then pitched underhanded, and the tester and patient play pitch-and-catch for a minute and a half. The tester should begin evaluation questions 15 seconds after the session begins.

After a minute and a half of fixation on the top ball, the tester then instructs the patient: "Now fixate on the bottom ball. We are going to play a game of pitch-and-catch by watching just the bottom ball." This pitch-and-catch continues for a minute and a half. The tester should begin evaluation questions 15 seconds after the session begins.

The tester should record findings. If the patient had no problems playing pitch or catch with either side, we record "no problems noted." After the patient has started throwing and catching while fixating on the bottom ball, the tester should ask the patient if it is easier to pitch and catch while looking at the top ball or the bottom ball. Also, the tester should ask the patient whether the world around them seems more normal or easier when they are viewing the top or bottom ball. The tester should report which eye gave the patient more trouble completing their task or made them feel more symptomatic; the top ball (right eye) or bottom ball (left eye).

Another of our goals with our testing is to isolate whether the right or the left side of the patient's vision causes them to become more symptomatic. The right side is more visually affected by the concussion when patients report that during the dissociated prism testing phase the upper ball causes more difficulty and when there is more difficulty or visual confusion with the bases yoked to the left. The left side is more visually affected by the concussion when the patient reports that the bottom ball causes more difficulty during the dissociated prism testing and that there is more visual confusion when the prisms are yoked to the right. By determining which side creates more symptoms, we can give the patient more information on why their visual system is not performing as expected (i.e., we can tell the concussed mountain biker why he needs to use his left eye).

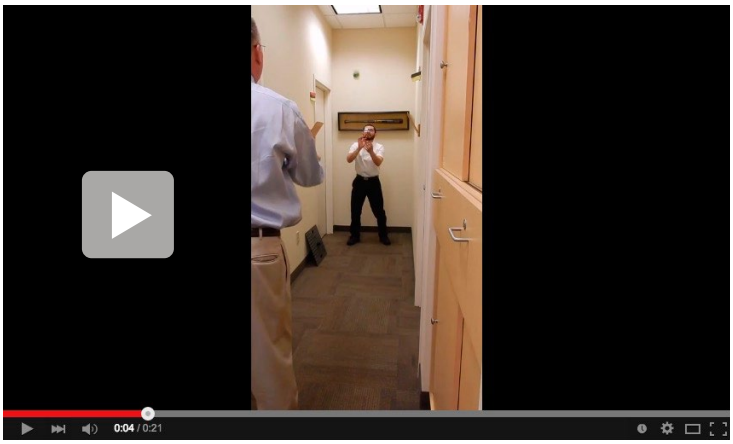
In our experience, the eye that gives the scissors reflex on retinoscopy and the eye that causes the images to move more on the Worth 4 Dot correlates to the same side of vision that is bothered in prism testing. This is also the side opposite to the midline shift. When the affected side becomes asymptomatic, the midline shift resolves.

If symptoms have not increased, we move to Stage 3 testing and again remind the patient to inform the tester if any symptoms arise. As discussed earlier, the tester should make note of symptoms that seem greater when the bases are yoked to the right (Stages 3 and 6) or left (Stages 4 and 7), as well as whether the upper ball or lower ball create more problems in Stage 2 and 5.

Another important note for the following stages that we have found from our observations: having a third person walk off to the side past the tester toward the patient and interrupting the testing seems to increase the vision concussion symptoms. This is randomly done only once or twice during the testing procedure if possible.

Stage 3: Yoked prism OD, 15 prism diopters base out (BO); OS 15 prism diopters base in (BI) (prism base yoked right)

Three minutes of pitch-and-catch with the patient standing on the floor.



Stage 4

Stage 4: Yoked prism, OD 15 prism diopters BI; OS 15 prism diopters BO (prism base yoked left)

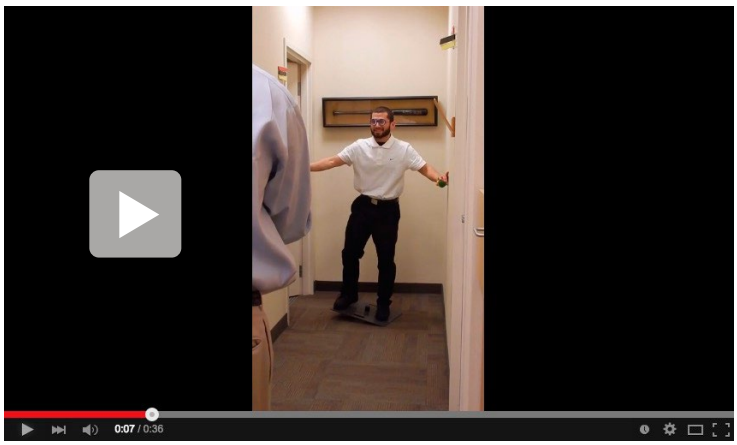
Three minutes pitch-and-catch with the patient standing on the floor.

Stage 5

Stage 5: Dissociated prism test (15 prism diopters base down (BD) OD and 15 prism diopters base in (BI) OS) + balance board

In this stage, the patient stands on a balance board while performing the pitch-and-catch activity described in Stage 2.

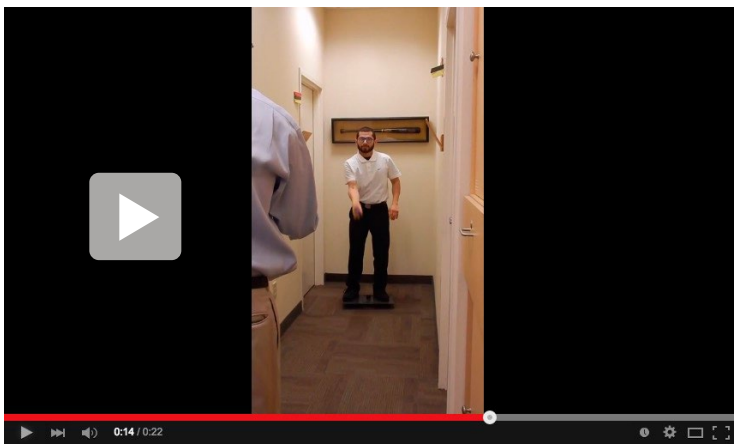
The tester will again direct the play of pitch-and-catch with the top ball for one and a half minutes and then use the bottom ball for one and a half minutes.



Stage 6

Stage 6: Yoked prism, OD 15 prism diopters BO; OS 15 prism diopters BI + balance board

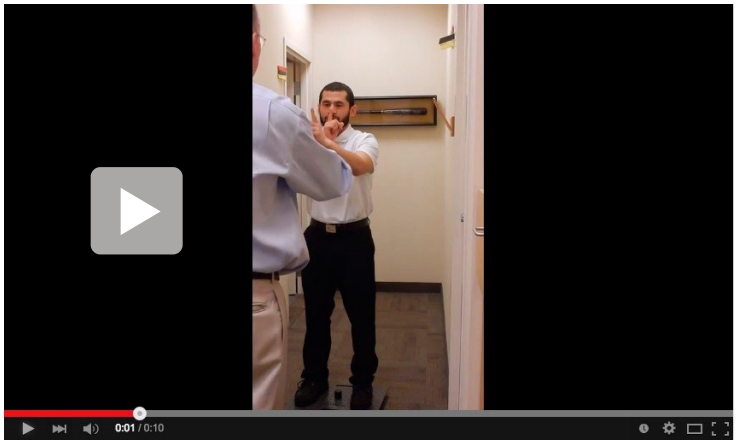
Three minute pitch-and-catch with patient standing on a balance board.



Stage 7

Stage 7: Yoked prism, OD 15 prism diopters BI; OS 15 prism diopters BO + balance board

Three minute pitch-and-catch with patient standing on the balance board.



Stage 8

Stage 8: Rotational-convergence test with the patient standing on the floor

Stage 8 has two components that are run simultaneously. Part 1 is the rotational component which incorporates vestibular testing, and part 2 incorporates convergence and divergence eye movements (Stage 9 incorporates a third level of testing by adding in the proprioceptive system of the body).

Figure 2: *Rotation limit to the left on the rotational convergence test*

Figure 3: *Rotation limit to the right on the rotational convergence test*

Part 1: Rotation

The patient will rotate their hips so that their nose is pointing at a 3 o'clock position (Figure 2). Then they will rotate to the left until they've completed a 180-degree turn and their nose is pointing at a 9 o'clock position (Figure 3). This rotation of 180 degrees should take between 4 and 5 seconds. Not all patients will have this flexibility, so they may alter their rotation to match their ability.

Part 2: Convergence

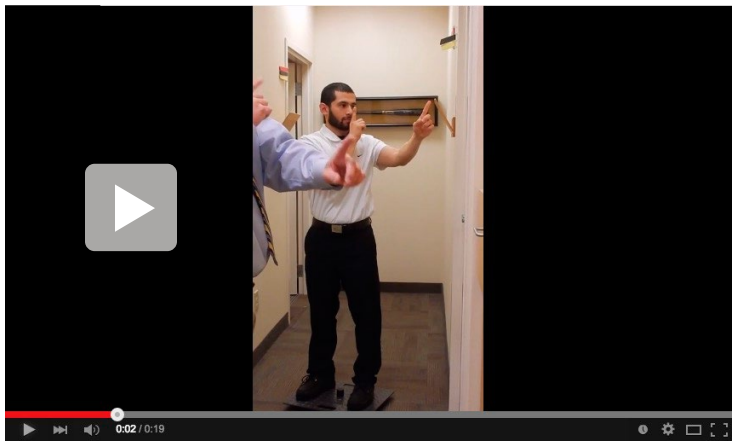
The patient should place their right hand in front of their face with their index finger pointing straight into the air, perpendicular to the ground, such that the tip of their finger is approximately 2 inches from their nose and at the same level as their nose. The right hand will stay in this position throughout the exercise.

Figure 4: *Straight ahead positioning on the rotational convergence test*

Figure 5: *The rotational convergence test performed on a balance board*

Their left hand should be raised with the index finger pointing in the same direction as the right hand; the tip of the finger should be at the same level as the nose and the right index finger. It should be at a distance of approximately 12 inches away from the right index finger or where the left arm is just less than full extension (Figure 4).

Test instructions: This test is timed for 3 minutes. The patient places their fingers at the proper positions and begins the rotation. The tester begins telling the patient to fixate on the tip of the right finger, then the left finger, then at distance (for example a spot on a far wall) and continues in a random pattern of changing fixation using these three fixation points (right finger, left finger, or distance). Fixation on one target should last up to 2 seconds. The patient is to report if they become symptomatic or their symptoms increase.



Stage 9

Stage 9: Rotational-convergence on balance board

The patient should stand on a balance board and complete the Rotational Convergence Test described in Stage 8 (Figure 5).

Stage 10: Vizual Edge computer test and final exam

Patients should be able to complete Vizual Edge testing without visual deficiency scores

and remaining asymptomatic. This assesses eye alignment, depth perception, convergence, divergence, and perception. More importantly, it gives a standardized score that relates the concussed or rehabilitated athlete/patient to a defined normal.

Doctor's final exam:

In this testing, the doctor repeats saccades/pursuits, near point of convergence, accommodative +/-2.00 D flippers, and Worth 4 Dot. An in-depth evaluation of symptom status is performed throughout the protocol.

The above testing is reserved mainly for our athletic concussion patients, which is the focus of this article. We have been able to alter some of our testing for those patients over 40, as well as those who have been injured in such a way that they cannot move, bend, or stand on a balance board. Therefore, the above protocol is not recommended for those patients with bodily injuries that impair their ability to stand or balance on their own accord.

Athletes who are able to pass all 10 stages of our protocol are deemed not to have a visual component to their concussion. This by no means allows them to return to play. We explain that our testing is for the visual system, and they need to continue follow up with their doctor for management of their concussion.

Athletes who have to stop testing because they become symptomatic have a visual component to their concussion. For athletes who exhibit diplopia or photophobia and cannot move to Stage 2 in testing, we recommend prescribing glasses with a blue tint (if there is a valid prescription) and returning for further testing in one week. Athletes who do not have a prescription may benefit from wearing sunglasses for their photophobia.

For athletes who are able to move past Stage 1 on their first visit but cannot pass all ten stages, we recommend prescribing changes in their refractive status and also beginning vision rehabilitation right away. Our rehabilitation plan revolves around weekly evaluations in our office and 15 minutes of daily home therapy. Our program will help them rehabilitate on average in 5.8 weeks as opposed to 12.3 weeks if they decide not to do therapy.

Our test protocol also helps decrease frustration in patients who feel like their progress is stagnant. They may originally only make it to Stage 2 on the first office visit but make it to Stage 4 on their second. We let our patients know that we are measuring progress and that they should feel good that they are improving. Many athletes have reported to us that this has given them hope during the healing process.

Home Rehabilitation Therapy

We give three exercises for patients to take home the first week. Each exercise is performed five minutes at a time or until the patient's concussion symptoms increase. We ask the patient to stop when they become symptomatic and begin the process again the next evening. We also educate the patient that they are only to do five minutes per exercise and no more. Some athletes hold hopes that if they do more exercises for longer periods of time, or if they work through their headaches, they'll rehabilitate quicker. That is not the case, and we have found that over-stimulation can lead to increased symptoms which other studies suggest are harmful.[7] We do not send home prism exercises because these exercises cause more symptoms, and therefore, patients need to be followed in a more controlled environment.

Home rehabilitation therapy works to improve the visual system's interaction with brain functioning in this order:

- Each eye's ability to communicate with the brain separately
- Each eye's ability to focus and to communicate to the brain
- Each eye's ability to converge and to diverge as a team

- The eyes converge, diverge, and focus as a team while working with the vestibular system
- The eyes converge, diverge, and focus as a team working with the vestibular system and the proprioceptors of the body
- Perception

The first week of exercises:

1. Red/Green Read: We dispense an 8.5" x 11" red/green tranaglyph reading page to be used over top of a Hart chart, along with red/green glasses. We recommend five minutes of regular reading concentrating on each letter for two seconds each.
2. Red/Green Read Flippers: We then ask the patient to do exercise 1 with +/-1.50 D flippers. Patients should flip the lenses after every three letters and perform this task for five minutes. (We use less power in the home exercises than in our testing protocol because our goal is to wake up and train the accommodative system while not overwhelming it. +/-1.00 D was not as effective.)
3. Brock string exercise for five minutes: We use a ten-foot Brock string and straight ahead gaze. Place the front bead 1 inch away from patient's nose or one inch behind the point where patient loses fusion; place the furthest bead at 6 inches before the end of the string, and the middle bead splits the distance between the two. If the patient has an A or V pattern in their convergence insufficiency, we may choose to train upward or downward gaze depending on the area of weakness.

At subsequent office visits, if patients report no difficulty or symptoms with their previous home exercises, we move them up to the new series of exercises:

1. Red/Green reading over light reading material for five minutes
2. Red/Green reading with the use of flipper over light
   reading material for five minutes
3. Rotational convergence exercise (as described in protocol) for five minutes

The last series of exercises:

1. Rotational convergence exercise while standing on a pillow for five minutes
2. Vizual Edge for 15 minutes

We ask that patients who are able finally to pass all 10 stages of the protocol, continue the last series of exercises five times a week for four weeks after being released from our care.

Subsequent Office Visits

Patients who do not pass the concussion protocol on their first visit are given the change in their refractive status when applicable, given home therapy exercises, and asked to return to our office in one week for a progress evaluation or in-office vision therapy.

Upon arriving, our para-optometric technician takes a complete history on the patient's progress during the past week. If the patient reports that they have been asymptomatic for over 48 hours, we will put them through the visual concussion protocol to determine whether their concussion has resolved. If they are still symptomatic, we will proceed with 20-40 minutes of vision therapy. We can train longer, in a more controlled environment, and stop quickly if patients have increased concussion symptoms.

We start with bi-ocular training, move to proper binocular function, and then help with perception. We also incorporate the prism pitch-and-catch techniques found in our protocol. Examples of in-office vision therapy:

- Red/Green Marsden ball
- Red/Green use with Fit Light Trainer:

First, we use two three-minute sessions with the eye/hand coordination mode using green lights and the patient wearing red/green

glasses, with the green over the favored eye for the first session and the non-favored eye for the second session.

Second, we use the random training session set to 50 hits, select only red and green lights to flash, and place red/green glasses on the patient such that red is placed over the non-favored eye.

Third, we've programmed a sequence to alternate brightly flashing red and green lights while patients are wearing red/green glasses.

Lastly, we perform any or all the above on a balance board.

- We use prism catch-and-throw as in the protocol.
- We use convergence/divergence and accommodative training methods similar to our non-concussed vision therapy patients.
- We use Vizual Edge Training at the end of the therapy protocol.

Conclusion

The Peters/Price (See To Play) concussion protocol is designed to diagnose concussions with a visual component. This tool helps to protect athletes from returning to play prematurely and also provides a treatment method to help athletes rehabilitate from the visual effects of their concussion so that they can return to play in a timely manner.

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Correspondence regarding this article should be emailed to Michael Peters, OD at mpeters@myeyedr.com.

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