

The Visual Error Scoring System: A Concussion Tool

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Postural stability and oculomotor function are the most easily recognized physical indicators of neurologic motor dysfunction associated with concussions.¹ Vision-based testing "is vital in the management of all forms of concussions and provides a sensitive approach for sideline or post-injury concussion screening."²

This report introduces the Visual Error Scoring System (VESS), an objective examination of oculomotor function. The system can assist in the evaluation of traumatic brain injury (TBI) by screening for impairments of eye movements, accommodation and other correlates of suboptimal brain function.³

Evaluation Tests

The oculomotor functions evaluated in the VESS examination include convergence, pursuits, saccades and fixations. Pursuits, saccades and fixations are tested with both horizontal and vertical trials. The patient is asked to perform the visual tasks while being observed for any errors. When the test is being performed, it is recommended to have an environment free of loud noises, bright lights and other distractions. **Convergence** is evaluated by having the patient watch the clinician's fingertip while it is moving slowly toward the bridge of the nose from about 60 centimeters away. The normal reaction is turning the eyes inward to focus at close range.

Pursuit tests evaluate the ability of the eyes to follow a moving target. The clinician's fingertip is held 30-45 centimeters away from the patient's face, and the patient is then asked to follow the fingertip with their eyes without moving their head. The clinician should move the fingertip across the patient's peripheral window in both directions, taking 2-4 seconds to span each direction. The **pursuit** test should include four passes performed horizontally and four passes performed vertically.

A **saccade evaluation** tests a person's ability to make accurate jumps between two targets. The clinician holds two fingertips at the patient's peripheral vision (about 30-45 centimeters apart). The patient is asked to focus on one fingertip and then focus on the other fingertip when prompted. The patient is asked to maintain their head in a neutral position during testing. The patient is first asked to pause for 1-2 seconds at each target, switching targets a minimum of eight times. Both horizontal and vertical saccadic movements should be evaluated.

A **fixation test** challenges the patient's ability to hold their eyes steady without moving off target. Patients are asked to focus on the clinician's fingertip while they rotate their head approximately 45 degrees to each side. The patient should perform two full rotations at the rate of one head rotation per second. Testing should also be performed for vertical fixation errors.

Errors include the inability to perform the task accurately, **nystagmus** and/or aggravation of

symptoms. Each error is scored as one point, with no limit as to the number of errors recorded. A score of zero indicates that no significant oculomotor deficits are present. If the presence of an error is noted or suspected, the task is repeated a total of three times to confirm a positive finding. Recording with a video camera can help confirm the findings and is a valuable tool for patient education.

Positive Findings

Individuals with neurologic deficits experience difficulty in performing oculomotor tasks and may respond with statements that the test is "too hard" to perform, "irritates me," or "hurts my head / eyes." A person with TBI may have difficulty following the instructions accurately and may show delayed processing in performing the examiner's request.

During convergence testing, one or both eyes may lose the target. When evaluating pursuits, the eyes may track inappropriately by moving too fast or too slow to follow the target. There may be vertical or horizontal deviations from a straight path while observing pursuits and saccades.

Saccadic testing may reveal delayed movement in one direction, difficulty acquiring the new target, and/or deviations from a straight path. During fixation testing, the eyes may drift off target. Nystagmus may happen at the beginning of a movement, in the process of moving, at the end of a movement or during fixation on the target while the head is moving.

The exacerbation of any symptom indicates that neurologic deficits are present and may include headache, dizziness, balance disturbance, fatigue and nausea. Confusion and irritability may be expressed as a result of oculomotor stimulation. The VESS examination is a pass / fail test: The presence of only one finding is evidence of abnormal oculomotor function and indicates neurologic dysfunction.

Discussion

The Visual Error Scoring System is a brief and easy-to-perform examination that can be performed immediately after injury or in the clinic. This examination takes approximately 2-3 minutes to administer and is simple enough to be performed by most lay people, including parents and coaches. With the use of a video camera, a self-evaluation can be recorded.

The VESS can be used as a sideline remove-from-play concussion screening tool. Combined with other concussion assessment tools, it can add to the body of findings to evaluate concussion severity and can be used to help determine when a player is able to return to activity.

In 2013, *Neurosurgery* published an article underscoring the need for the [King-Devick test](#), a basic, yet highly predictive sideline test that can be performed by laypersons during a game to determine concussive and subconcussive events.⁴ The investigators stated that, because most athletes play at the youth sports level and are not in a college or professional setting, important medical decisions are often left to coaches and parents.

Thus, a test that can be performed by a coach or parent is needed, especially with the increasing evidence suggesting that even mild impact to the head can lead to accruing neuropathology. It is recognized that vision is often compromised during mild TBI. Therefore, tests of visual functioning could rapidly assess an athlete after a head injury.⁵

A retrospective study found that postinjury testing of athletes with the King-Devick test and Standardized Assessment of Concussions and Balance Error Scoring System identified 100 percent

of concussions.⁶

Food for Thought

The Visual Error Scoring System yields clinically objective measurements of neurologic function, providing the health care practitioner with accurate data for clinical decision making. As a clinical tool, it can aid in identifying ongoing neurologic deficits. Clinical studies are needed to verify the validity and reliability of this test.

Editor's Note: copy Dr. Turnbull provides a free VESS exam sheet at www.drtoodturnbull.com/more/ and a video demonstration of the VESS evaluation tests discussed in this article [on YouTube](#).

References

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