Research to identify biomarkers in mild traumatic brain injuries

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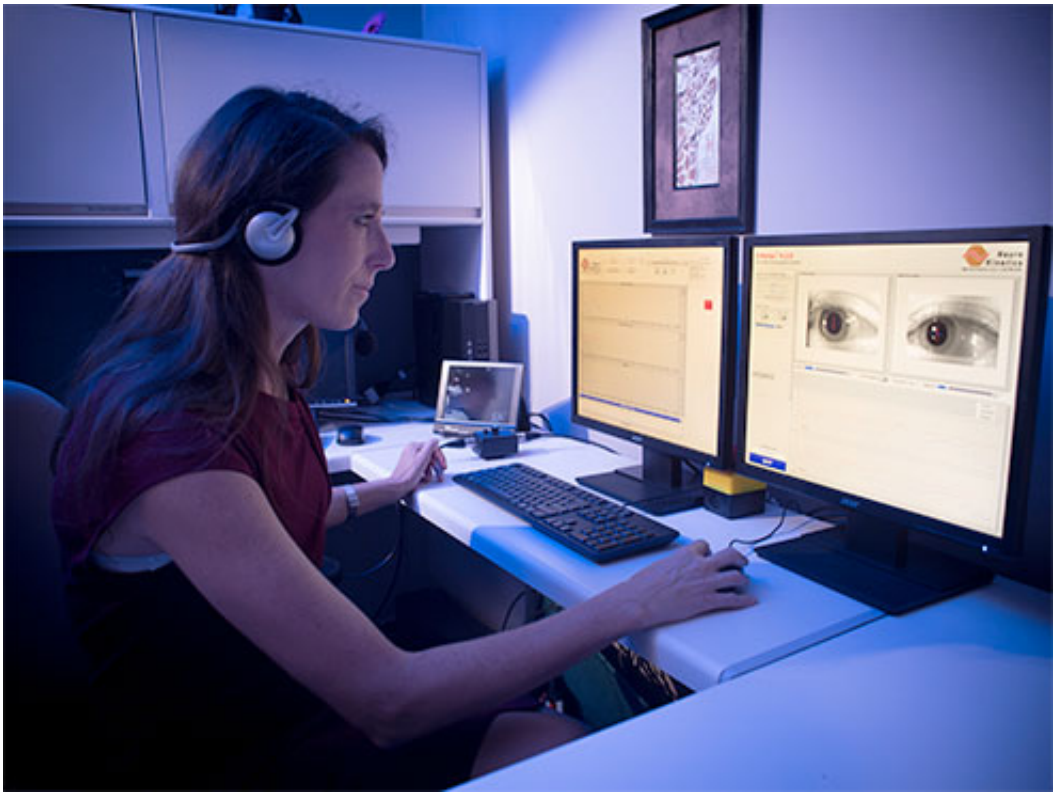

Jennifer Christy, PT, Ph.D., looking at computer monitors showing images from 250 Hz goggle eye tracker system for non-vestibular eye movement studies.

Lewis Rand, an active 10-year-old, suffered a mild traumatic brain injury Oct. 20 during soccer practice when he fell, hitting his head on a metal post.

As he did not lose consciousness, Lewis did not think anything of the incident and continued practicing. But as symptoms developed over the following days, Lewis was ultimately referred to Children's of Alabama, where his concussion fit the criteria to be involved in the ongoing research within University of Alabama at Birmingham School of Optometry's Vestibular and Oculomotor Research Clinic, or VORClinic.

His mother, Anne Rand, noticed a change in Lewis' eating habits, stamina, engagement in his schoolwork and health; he was pale and had clammy skin and headaches. Lewis was not having the more recognizable signs of concussion—blurred vision, seeing double or vomiting. His symptoms were more subtle and hard for a 10-year-old to describe.

Anne took him to their pediatrician, where they performed a series of neurological tests. Lewis passed all the tests.

The next day, Lewis seemed to be feeling better and returned to school, but was sent home within a few hours. Anne called the pediatrician back. Lewis' pediatrician recognized that he had a mild concussion, recommending that he rest over the weekend.

Lewis' symptoms continued over the next two weeks; primarily he was having trouble reading and focusing on schoolwork, and he experienced fatigue and headaches. He was referred to Children's of Alabama's concussion clinic. "That was the first part of our journey," Anne said. "During our initial visit, they noticed tracking issues with his eyes."

Erin Swanson, M.D., recognized Lewis' eye tracking and convergence issues and identified him as a prime candidate for the VORClinic, a multidisciplinary team of clinicians and scientists focused on concussion research that was introduced in April.

"Many of the children we see have problems with vision or balance, which is a common finding in the course of diagnosing a concussion," said Drew Davis, M.D., associate professor in the UAB Departments of Pediatrics and Physical Medicine and Rehabilitation. "Depending on the findings during these tests, we refer the patient to the VORClinic, where we are trying to understand more about which elements of vision and balance are impacted by a concussion."

"We currently do not have great biomarkers to identify a concussion," Davis said. "It is generally diagnosed based on the history, mechanism of injury and complaints by the child. The VORClinic is currently looking for an objective finding related to assessment of vision and balance to help us diagnose concussions and track recovery over time."

UAB Department of Physical Therapy Associate Professor Jennifer Christy, P.T., Ph.D., and School of Optometry Professor Mark Swanson, O.D., MSPH, are part of the VORClinic team working with concussed and nonconcussed patients in various levels of contact and noncontact sports.

Together, they performed a multitude of exams on Lewis. Some were the traditional tests in a pediatric eye exam: visual acuity, eye coordination and alignment, and ocular health. Balance was also tested by traditional means. Other testing was state-of-the-art and available to only a handful of clinics across the country.

The vestibular-ocular reflex, or VOR, is the body's way of keeping images seen by the eye still even during body movement, like walking and looking at street signs or running back to throw a football. The clinical research team thinks the VOR may be affected in concussion, leaving the athlete with vague symptoms of headache, nausea and balance issues.

While traditional tests can evaluate the vision system and the vestibular system separately, the VORClinic team hopes to test the vestibular-ocular system as a whole using cutting-edge equipment not available to civilians anywhere else in the state. Exams include the sensory organization test, vestibular evoked myogenic potential (VEMP), and Neuro Kinetics, Inc., rotary chair testing.

During the sensory organization test, the athlete stands as still as possible during six sensory conditions as the sensory organization test looks at the postural control biomarker and the sensory system's contributions to static balance.

The VEMP test measures activity in the sternocleidomastoid muscle, located in the neck, via electromyography, an evaluation of electrical activity produced by skeletal muscles in response to sounds in the ear. The saccule, a bed of sensory cells located in the inner ear that translates head movements, is the biomarker of interest testing the inferior vestibular nerve, and is related to the vestibulospinal system which contributes to balance.

A 30-minute screening in the NKI rotary chair tests a variety of biomarkers, including angular vestibular ocular reflex via the horizontal semicircular canal and superior vestibular nerve, oculomotor function and ultricular pathways.

During this portion of the exam, the athlete sits in a chair in a pitch-black room testing the movement of the eyes in response to motion and light. The athlete is examined on smooth eye movement by following a moving target, watching light dots as they move across the visual field, eye movements as the chair moves slowly and quickly left to right, and setting a light bar to perceived vertical. The athlete wears goggles with high-speed and high-resolution cameras that capture the most subtle eye movements, so Christy is able to watch the eyes and monitor the

corresponding eye movement tracings on her computer monitors.

Lewis had a normal response to the VEMP test, which showed that his saccule and inferior vestibular nerve were functioning well. He also demonstrated excellent balance during the sensory organization test. While testing Lewis' inner ear and the vestibular pathways, he generated a good vestibular ocular reflex gain. In other words, when his head moved to the left, his eyes moved to the right and vice versa.

However, after looking at Lewis in the NKI rotary chair, Christy found that his smooth pursuits were not moving as smoothly as in a nonconcussed patient. In addition, when he was trying to move his eyes quickly to a target, he was overshooting it more than would be expected.

"Lewis appears to have visual oculomotor pathway issues, suggesting that Lewis might benefit from visual therapy," Christy said.

The goal of the VORClinic is to inform people that concussions affect the central nervous system, the ability to move the eyes rapidly and gaze stability. All are important functions in playing sports and success within in the classroom. The later research will help develop the evidence needed to treat concussions and to help the athlete successfully return to play safely and return to the classroom efficiently.

"In our research, we hypothesize that athletes who are concussed will have different eye movement than those nonconcussed athletes. We are also looking at the athlete's sport and concussion history—how long they have been playing and what other sports they are involved in," Christy said. "We hypothesize that perhaps athletes who have been playing contact sports for a longer period of time may have slower eye movements and may not be moving their eyes as smoothly as athletes who have not experienced contact sports or obvious head trauma. We want to see if the eye can tell us more about the brain."

The VORClinic is currently recruiting healthy athletes ages 8-24 with or without concussion during the season of play to participate in the study. Participants will receive an optometry examination, as well as an examination of the vestibular, oculomotor and balance systems at no charge. The athletes will help the VORClinic team develop more measureable, recognizable signs of concussion in the hopes of keeping young athletes safe and active.

Provided by University of Alabama at Birmingham