While ophthalmologists have always known that the eyes can reveal information about the rest of the body, other specialties are just now figuring that out, said Uzma Samadani, MD, PhD, FACS, FAANS, chief of neurosurgery, New York Harbor HealthCare, New York University (NYU) School of Medicine, New York. Dr. Samadani has been taking advantage of the eyes as a way to access the brain in order to better diagnose and track the progress of patients with concussions and other brain injuries. She presented her research findings in “Detecting Concussion with Eye Tracking” at the Women in Ophthalmology (WIO) 2014 Summer Symposium in Leesburg, Va.

Faced with a scarcity of neurological tests for quantifying brain injury outcomes, Dr. Samadani turned to an ophthalmic approach. “For as long as people have been examining brain injury patients, they have made an association between abnormal eye movements and brain injury,” she said, so using eye tracking as a measure of brain injury was a natural step.

The problem with treating brain injury, Dr. Samadani explained at the meeting, is that it covers such a wide array of conditions—from focal injuries such as epidural hematomas to diffuse injuries such as concussions. What complicates matters is that diffuse injuries are incredibly hard to diagnose. “If you look at the word ‘concussion,’ there are 42 different definitions,” she said in a video interview with Eyeworld. “And that’s created a lot of problems because if you can’t define something, how can you diagnose it?”

Neurologists have historically relied on imaging methods to detect brain injury, but concussive injuries may be elusive—they often do not show up on CT or MRI scans. But if there is a quantitative difference in the eye movements of patients who have concussions versus patients who have no brain injury, the technique could be used to diagnose the injury and track a patient’s progress in recovery, Dr. Samadani said. “We believe that eye tracking could potentially be used as an outcome measure that will predict when patients are getting better,” she said. “That’s something that’s very valuable in terms of trying to figure out when to return an injured person to work or play.”

The window to the brain

The goal of Dr. Samadani’s research was to develop an eye tracking method that could detect and quantify the severity of a concussive brain injury. The experiment she designed was simple: determine how well patients with concussions watch television compared to those without.

Her team had patients watch a video that moved around the screen in a fixed pattern. Their experiment tracked each person’s eyes individually as he or she followed the video around the screen, and then assessed the conjugacy—how well the 2 eyes moved together—in both the horizontal and vertical directions.

They tested the method by examining patients with known neurologic abnormalities such as cranial nerve palsies that would prevent the eyes from moving together and comparing the results to non-injured patient controls. After determining what was normal and what was abnormal, Dr. Samadani’s team performed a prospective observational study of patients recruited from the emergency room (ER) trauma and neurosurgery units of their hospital.

The team examined 75 trauma patients that were divided into 3 groups—a structural brain injury group, with head injuries detected on a CT scan; a nonstructural brain injury or concussion group, with injuries not detected on a CT scan; and a non-brain injury group, which presented to the ER trauma unit but did not require a head CT.

They then correlated the eye tracking abilities of each patient with standard concussion assessment measures as well as a symptom severity score and followed each patient for up to a year post-injury.

The results showed that eye tracking abilities were quantifiably different between the 3 study groups—there was a statistically significant difference between patients with structural brain injuries and non-brain injured controls, and concussion patients fell in between. What Dr. Samadani also found is that both structural and nonstructural brain injury patients do improve over time, but recovery times are inconsistent—some patients recover quickly and others recover slowly.

‘It’s all in your head’

Now that Dr. Samadani’s team has shown there are quantifiable differences in eye tracking abilities in brain-injured patients versus controls, they can provide better care to patients who have suffered concussions but show no evidence of it on a CT or MRI scan. “Prior to this kind of technology, a lot of these patients would have been told ‘this is all in your head,’” Dr. Samadani said. Despite the lack of visual evidence, the physiological effects are real, she emphasized, and patients’ complaints of lingering symptoms should be taken seriously.

Dr. Samadani suggested that eye tracking may serve as a marker for different types of neurologic disorders, including elevated intracranial pressure, hydrocephalus, multiple sclerosis, and even dementia.

In her video interview, Dr. Samadani highlighted the need to differentiate between different forms of dementia to provide the appropriate care. If a neurologist could detect the difference between normal pressure hydrocephalus (NPH) dementia versus Alzheimer’s dementia, for example, the physician could determine who needs a shunt and who does not.

“The goal is to catch them early,” she said. “What we think based on our preliminary research with some mild cognitively impaired patients at NYU is that we can detect NPH before other modalities. Then we can treat these patients earlier, and we can see them improve or not deteriorate.”

Editors’ note: Dr. Samadani has intellectual property assigned to NYU and the Veterans Administration and equity in Oculogica Inc., a company that has licensed this intellectual property.

Contact information
Samadani: uzma.samadani@nyumc.com