

The Qmetrics PCS Index

See Your Concussion

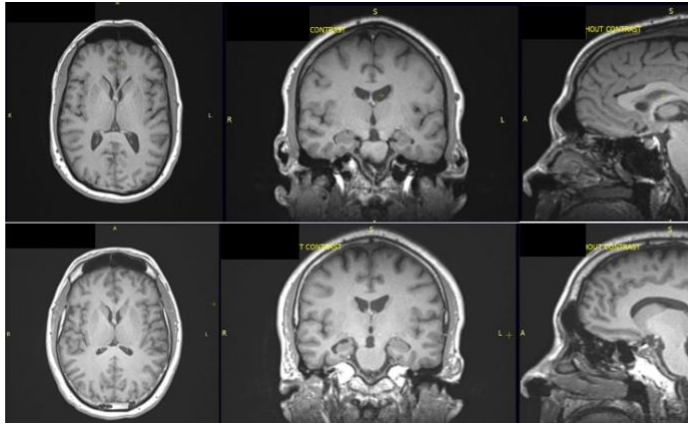


Figure 1- MRI Scans of Injured and Healthy Subjects



Can you see any difference between the scans of healthy and injured subjects?

An expert Neuroradiologist couldn't.

The Qmetrics PCS Index Can.

Post-Concussive Syndrome Index

Background

Mild Traumatic Brain Injuries (mTBI), more commonly known as concussions, occur frequently due to collisions or falls in sports or accidents in daily life. Most concussions improve within a couple of weeks, but some people experience symptoms such as headaches, brain fog, light sensitivity or other post-concussive problems that linger well after the injury occurred. These persistent symptoms that result from a concussion can be diagnosed as Post-Concussive Syndrome (PCS). Often, patients diagnosed with PCS are referred for MRI imaging to determine if a cause for the patient's symptoms can be identified. In almost all cases, these imaging exams appear negative because the post-concussive microtrauma to brain tissues is impossible to detect via conventional radiological observation.

Discovery

Dr. Stephen Meyers, a neuroradiologist in Rochester, NY, found it frustrating to be unable to see anything abnormal in the MRI exams of patients he knew were not well, having been referred to him after they were diagnosed with PCS. Qmetrics worked with Dr. Meyers to compare MRI exams of PCS patients with those of a group of similar people with no history of head injury.



Stephen P. Meyers, MD, PhD

Qmetrics collected over 4,000 advanced radiomic measurements from the MRI exams, measuring the patterns and textures of both structural and diffusion images. To discover which measurement, if any, identified the post-concussive microtrauma, we used a type of artificial intelligence called machine learning to sift through the massive amount of data and reveal a subset of measurements that best identified the injured patients from the ones with no injury. These measurements comprise the PCS Index and are based on both structural gray and white matter features as well as diffusion metrics (diffusion imaging measures how easily water molecules travel in specific directions). The study, and more scientific descriptions of methods and results are published here: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8784748/>.

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What Does the PCS Index Detect?

The PCS Index detects a combination of subtle changes in both gray and white matter. Some of the changes relate to water molecules moving in unusual directions. White matter axons are long, tendril-like parts of neurons that convey signals to different parts of the brain. Like water in a straw, fluid can travel along the length of the axon and its tubular structure constrains the fluid to travel along its length. When the axon is damaged, fluid may leak out like water in a cracked straw and the unusual movement of water molecules is reflected in subtle signal changes in the diffusion scans. Taken all together, the measurements of structural and diffusion signals are combined to indicate the probability of post-concussive injury.

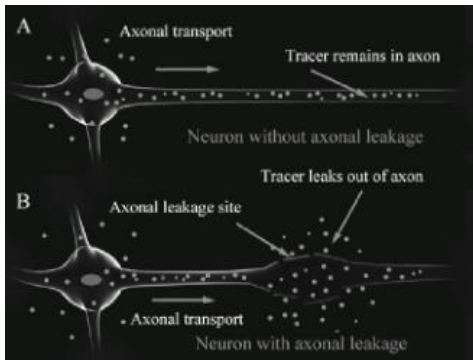


Figure 2: Illustration of Intact vs. Leaking Axon

Performance Testing

Next, we wanted to test how well the PCS Index would perform in the real world - with a broad range of ages, causes of injury, on different MRI machines, etc. Under a new study sanctioned by the University of Rochester, Qmetrics retrospectively collected routine clinical neuroimaging MRI exams for both patients diagnosed with PCS and for patients being seen for a variety of reasons unrelated to any prior head injury, such as hearing loss. We computed the PCS Index values for over 500 subjects between 18-95 years old and found the PCS Index was **over 90% accurate** in indicating subjects with prior mTBI from those without, regardless of gender, age or mechanism of injury. Results were unaffected by the specific MRI machine used (both Siemens Trio 3T scanners), and by the number of gradient directions (70 vs 12) for the diffusion imaging series.

Clinical Utility

The PCS Index provides an **objective assessment** of brain structural abnormalities, or microtrauma in mTBI patients. This effectively enables doctors to “see” the post-concussive injury, in addition to assessing the patient’s symptoms and dysfunction. It can also provide confirmation to patients that their symptoms are real and likely related to brain injury. Understanding the extent of brain microtrauma may also support therapeutic decisions or add confidence to recovery milestones.

Availability

Qmetrics developed the PCS Index to provide everyday patients with access to sophisticated image-based analysis techniques which historically are only accessible to academic researchers, and too laborious to be practical for clinical use. Leveraging the infrastructure we developed to serve worldwide clinical imaging studies, we can provide PCS Index results to clinicians via our secure online image data portal and our imaging core lab. The PCS Index was developed as a Laboratory-Developed Test (LDT), administered in our core lab under the supervision of Saara M.S. Totterman, MD, PhD. Dr. Totterman is a board-certified radiologist with lengthy experience in advanced image analysis. Our services are HIPAA-compliant and provided under our Quality System, which has been successfully audited by both our commercial clients and the FDA.

Please contact Qmetrics to learn more about the PCS Index and how we can help you and your patients “see” their post-concussive injury.