Microsaccadic Fixational Eye Movements as an Oculomotor Marker for Concussion

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Objective:
To identify whether concussion causes abnormalities in fixational eye movements, specifically the generation of microsaccades.

Background:

Microsaccades are microscopic rapid eye movements that occur normally with attempted fixation. However, changes in microsaccade rate, magnitude, etc have been linked with neurologic and ophthalmic pathologies.

Design/Methods:
We collected baseline data for college athletes (n=116) at Sterling College (Sterling, KS) as they reported for the physical examination before the beginning of the athletic season. None of the athletes had a prior history of concussion. Concussion patients (n=86)were selected from patients who had an initial visit for concussion at a private concussion clinic. Patients were included if they presented within 50 days of injury. All participants were between 18 and 23 years of age. For each participant we measured the number of saccades generated, the size and speed of the micro saccades, the area covered and the ratio of vertical-to-horizontal direction component of the fixational eye movements, using a 250 Hz video-eye tracker mounted inside a HTC Vive VR headset. Participants were instructed to fixate on a central dot for 140 seconds, in 20-second intervals. We performed a logistic regression with the log-transformed oculomotor characteristics as independent variables and concussion yes/no as dependent variables. Errors are presented as standard error from the mean.

Results:
The average microsaccade magnitude was higher in concussed than in non-concussed participants (1.85 ± 0.12 degrees vs 1.32 ± 0.06 degrees, $p < 0.001$). Similarly, the fixational eye movements (microsaccades+drifts) of concussed patients tended to cover a more vertical area during fixation periods (vertical-to-horizontal ratio of 3.49 ± 0.94 vs 1.12 ± 0.04, $p < 0.005$).

Conclusions:
Oculomotor testing, specifically microsaccades is a potential marker for concussion. Concussion patients present larger and more vertical eye movements during fixation.