

# Could small repeated head hits cause major damage?

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University of Rochester Soccer Player Heads Ball. Credit: Rochester Athletics

The impact makes us cringe—the sound of two helmets making contact during a football game, a player down on the field. Questions swirl: "How badly is he hurt?" "Are his limbs moving?" "Does he have a

concussion?" "Will this take him out of this game or many?"

But what about all the other hits to the head—like the impact with the ground during a tackle, hitting another helmet during a block, a foul tip off a baseball bat into the player's mask during a game or practice, a player heading a soccer ball towards the goal? Players can often stay in the game for the short term, but what do these hits to the head mean for their long-term brain health?

Concussion research has led to concussion protocols, which are changing the game for contact sports. These range from [professional athletes](#) having to follow multistep protocols before returning to play to youth soccer players not being allowed to head the ball until they are 11.

It is widely understood that a concussion needs treatment and care, much like a bad sprain or broken bone. But what about when someone hits their head once, twice—or multiple times—without apparent injury?

Jeff Bazarian, MD, professor of Emergency Medicine and Neurology at the University of Rochester Medical Center, whose research has transformed what we know about concussions, believes these repeated hits to the head are a silent danger. Each blow can compound the one before, sometimes without symptoms to warn of a growing injury.

When a person's occupation or activity exposes them to repeated head hits—like members of the military or athletes—they can experience subtle declines in neurologic function, such as balance, eye movements, and rapid decision making. These declines in neurologic function are not currently detectable by a doctor but can impair athletic or military performance and increase the risk of sustaining other injuries.

In the long term, these repeated head hits may contribute to developing serious neurodegenerative diseases or disorders. However, unlike

concussion, there is no current standard of care to track, prevent, or treat these hits because there is still much to learn about them.

"We're trying to determine if we can detect and mitigate the acute effects of exposure to repetitive head hits on the brain. Do these hits alter neurologic function in a way we can pick up using objective measures suitable for use in low resource environments like battlefields and athletic fields?" said Bazarian.

"If so, what can be done to return neurologic function back to baseline as quickly as possible? In a sense, we are borrowing from the field of occupational medicine by applying a brain health monitoring approach to individuals exposed to an environmental factor (repetitive head hits) that increases their risk for neurologic injury.

"Our hope is that one day this approach may lower the longer term risk of neurodegeneration in those exposed."

Bazarian plans to lead a four-year, multi-pronged, and multi-site study to better understand these repetitive hits to the head, with goals to find ways to detect, prevent injury, and treat them.

## **Building the team**

Four institutions will recruit and track college athletes for this study. In the fall, researchers will recruit male football players and female soccer players from teams at the University of Rochester, University of Buffalo, Indiana University, and The Citadel, a military college in South Carolina.

Participants will wear mouthguards with special sensors during every practice and game to keep track of the number of head hits and magnitude, including direction and force, and [brain proteins](#) in the blood

will be tracked before and after games.

[Previous research](#) has shown that the brain protein GFAP is elevated after a single [football game](#) and that elevation is related to head hits. Last year, the FDA approved a [blood test](#) to detect GFAP and the brain protein UCHL1 to be used to determine if a person with a concussion needs a CT scan.

Participants will also complete several tests before and after a handful of games during the season.

Before & after game tracking tests:

- Quantitative EEG—five minutes of brainwave activity.
- Blink reflex to test eye lid closure reaction time.
- Hand-eye reaction time.
- Near-point convergence—measuring the point of focus of a single pen point moving toward the eyes. The range can vary by 2–6 centimeters before and after a game.

Researchers anticipate finding subtle abnormalities in athletes' performance on these tests, but none can currently be used as a diagnosable tool in the clinic.

"A soccer or football player can go through a whole season of repeated head hits and have no symptoms and a normal physical exam. But we hypothesize that one of these tests, or a combination of them, will be a little bit abnormal," said Bazarian, "and that these abnormalities will correlate with head hit exposure and with neurologic injury in our reference standard, changes in structure of the retina of the eye."

## Seeing into the brain

Researchers aim to see this change in the brain using optical coherence tomography (OCT). This non-invasive imaging technique uses light to create pictures of the back of the eye, including the retina and nerves coming from the brain. This tool is widely available at ophthalmologist offices and provides consistent outputs between machines.

Bazarian and retina expert Steven Silverstein, Ph.D., professor of Psychiatry, Center for Visual Science, Neuroscience, and Ophthalmology, have already used this technique to correlate the number of head hits some University of Rochester football players have had during a season to changes to their retinas.

## **Could time or exercise be treatment approaches?**

At the end of the football and soccer seasons, researchers will split the athletes with evidence of clinically silent neurologic abnormalities from repetitive head hits into two groups. One group will rest for two weeks. The other group will be treated with a daily aerobic exercise for 20-30 minutes. The latter is the current standard of care for a concussion.

Researchers anticipate that more subjects in the aerobic exercise group will have improvements in neurologic function than in the rest group.

But what about during the season? Is there a threshold of head hits that a player can sustain and stay healthy? Or is it less about the number of hits and more about the interval of time between the hits? Using a soccer ball heading machine, researchers will closely monitor participants who head the ball in sessions every day and compare those who have days off between heading sessions.

"The question is, if we put some time between these sessions of head hits, does that reduce the impact of these head hits on these subtle neurologic changes," said Bazarian. "We think it probably will."

## How many hits are too many?

Researchers will also investigate if there is a threshold for how many head hits the brain can sustain before abnormalities present. Using an [animal model](#), study co-investigators at Boston Children's Hospital will try to understand if there is a threshold number of hits below which there is no demonstrable brain injury, or if all hits are harmful.

Provided by University of Rochester Medical Center

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