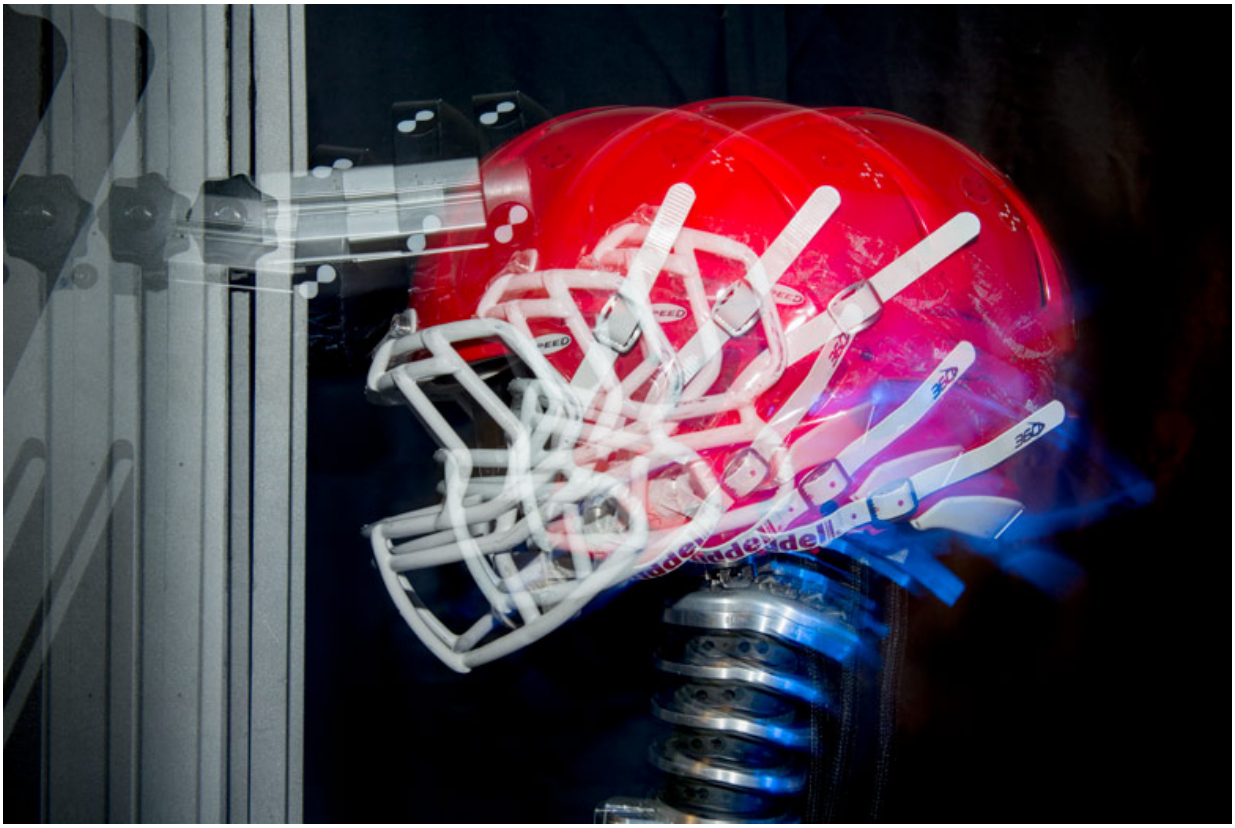
Medical Xpress

Research suggests football helmet tests may not account for concussion-prone actions

July 20 2015



Stanford research suggests that current football helmet tests may miss concussion-prone actions. The researchers are currently testing a new apparatus (above), consisting of a dummy head mounted on a biofidelic neck, that they hope will simulate more realistic field impacts. Credit: L.A. Cicero / Stanford News Service

When modern football helmets were introduced, they all but eliminated traumatic skull fractures caused by blunt force impacts. Mounting evidence, however, suggests that concussions are caused by a different type of head motion, namely brain and skull rotation.

Now, a group of Stanford engineers has produced a collection of results that suggest that current helmet-testing equipment and techniques are not optimized for evaluating these additional injury-causing elements.

The ideal way to test any protective gear is to gain a sense of what causes the trauma, set up a system that replicates the way the trauma occurs, and then evaluate the gear against the injury-causing criteria. For the past several years, David Camarillo, an assistant professor of bioengineering and, by courtesy, of mechanical engineering at Stanford, and his students have been collecting and analyzing data in hopes of identifying the signature skull motions that cause concussions.

The brain is like a bowl of Jell-O. Give the bowl a push, and the dessert takes some time to react, but once it gets moving, the Jell-O overshoots its limits and begins wiggling back and forth. This period of brain movement within the skull is a potentially dangerous time for injury to occur.

Acceleration is important, but so is the timing of deceleration, Camarillo said. If the bowl moves forward right as the Jell-O is decelerating backward, it could cause the Jell-O to deform even further.

"The same is true for the brain moving within the skull," Camarillo said. "It's possible that injury happens when the head whips back and accelerates the brain in one direction right as the brain is starting to go in the opposite direction."

Camarillo's team first set out to determine what degree of oscillation is

dangerous. They fed pre-existing MRI data into a computer model of the brain, and found that the brain's relative motion is amplified when the head oscillates at 15-20 Hz, completing a single back-and-forth motion in about 50 milliseconds.

They compared this to field data of sports-related head impacts - which they had collected over the past several years from Stanford football players who wear mouthguards instrumented with accelerometers - and found that players frequently experienced head oscillations in the 20 Hz range.

"We know that if the head shakes at that frequency, the brain starts to rattle more violently," said Kaveh Laksari, a postdoctoral scholar in Camarillo's lab, and first author on the paper. "So we have this mechanical system that exhibits a dangerous mode of motion, and then we find that the in-game impacts excite it at that frequency or something close to it. This introduces a fresh viewpoint on the possible cause of repetitive brain trauma. We need to keep that in mind when we're designing protective equipment."

Testing the test

The standard test for every football helmet used in the NFL or NCAA involves a guillotine-like device that drops a helmet-clad dummy head from multiple heights to approximate various impact magnitudes.

But when Fidel Hernandez, a Stanford doctoral candidate in mechanical engineering, began comparing results from this drop test to what Camarillo's group had observed in the field, it was like looking at two different data sets.

High rotational velocities, which are thought to induce brain strain and have been predictive of concussions, were observed in the field impacts

but not the drop tests. And while field data showed rotational head motions in the 15-20 Hz range, drop tests generated much faster, 100 Hz movements.

Similarly, rotational accelerations were substantially lower in certain drop tests. Drop testing was also unable to produce accelerations across the full six-degrees-of-freedom spectrum of directions observed in field impacts, and which Camarillo's group has previously shown are important factors in an injury.

"The problem with having a model that doesn't re-create what players actually experience in the field, is that you could optimize a helmet to perform well in the drop test that unintentionally performs poorly in the field," said Hernandez, who was lead author on the study. "For instance, you could design a helmet to stop linear head motion or high-frequency head vibration, because that shows up in the test, but that might not be what is most dangerous to your brain."

Setting a new standard

The new work suggests there's room for improvement, Camarillo said. Currently, the two primary tests for evaluating helmet safety measure the duration of the acceleration for only 15-36 milliseconds, which he said is probably too short a period given that the brain takes more than 50 milliseconds to begin moving, and the real injury may occur after that.

Camarillo's group is testing a slingshot-like system that propels an impactor into a stationary head to test impact velocities and accelerations in six degrees of freedom. They are also experimenting with various crash-dummy necks to make sure that it flexes in a way that is more similar to actual humans, and testing if tweaking the drop test could help it better mirror field data.

The work, and ultimately identifying the key trauma-inducing factors, has a long way to go, Camarillo said, and could benefit from stricter guidelines.

"My opinion is that there should be some government regulation in standardizing helmet tests," Camarillo said. "Hopefully people can use the methods we've described here to show that impact forces are being reproduced sufficiently or realistically compared to what's happening in the field."

Provided by Stanford University

Citation: Research suggests football helmet tests may not account for concussion-prone actions (2015, July 20) retrieved 4 May 2024 from https://medicalxpress.com/news/2015-07-football-helmet-account-concussion-prone-actions.html