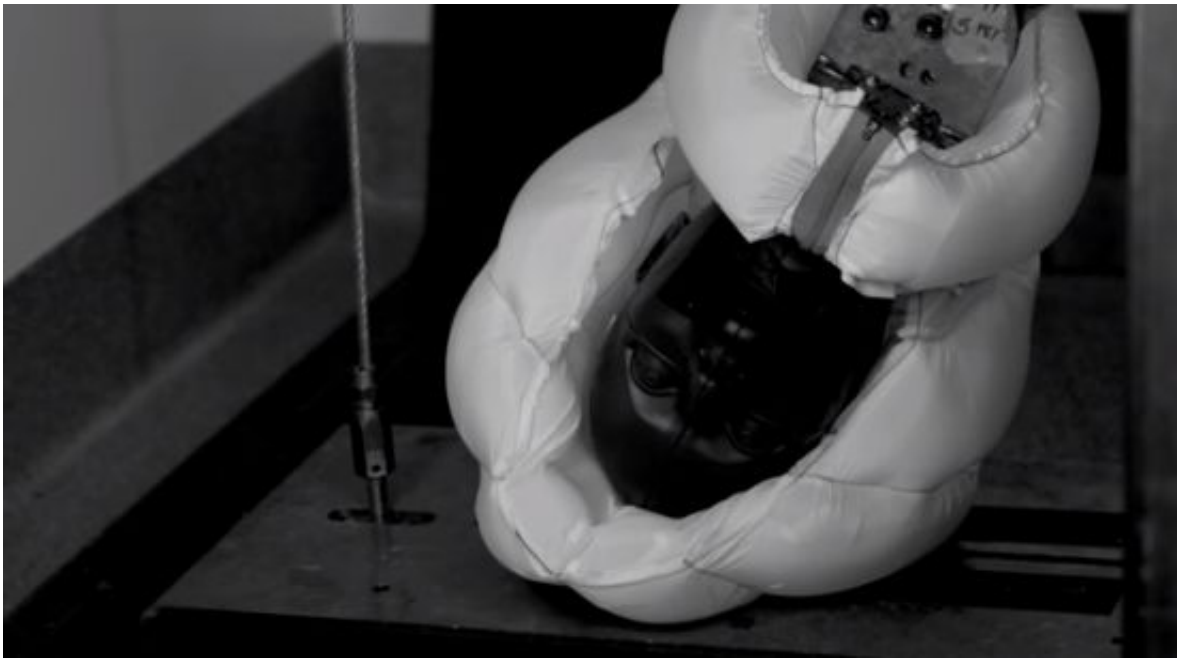
Researchers show air bag bike helmets have promise

October 4 2016, by Taylor Kubota



Stanford bioengineer David Camarillo knows all too well that bicycling is the leading cause of sports- and activity-related concussion and brain injury in the United States. He's had two concussions as the result of bicycling accidents. While he doesn't doubt that wearing a helmet is better than no helmet at all, Camarillo thinks that traditional helmets don't protect riders as well as they could.

"Foam bike helmets can and have been proven to reduce the likelihood of skull fracture and other, more severe brain injury," said Camarillo, an assistant professor of bioengineering at Stanford. "But, I think many falsely believe that a bike helmet is there to protect against a concussion. That's not true."

Knowing what he does about traditional bike helmets, Camarillo, whose lab works on understanding and preventing concussion, decided to test a new type of helmet that is starting to be available in some European countries. The results are included in the Sept. 27 edition of Annals of Biomedical Engineering.

Reduced acceleration

The helmet Camarillo tested comes in a soft pocket worn around the neck. It pops up, like an air bag, around a person's head when it senses a potential collision. It was originally designed to address the fact that people don't like to wear helmets for aesthetic reasons. The researchers compared this air bag helmet directly to traditional foam bike helmets. Their results were striking.

"We conducted drop tests, which are typical federal tests to assess bicycle helmets, and we found that air bag helmets, with the right initial pressure, can reduce head accelerations five to six times compared to a traditional bicycle helmet," said Mehmet Kurt, a postdoctoral scholar in the Camarillo Lab.

The drop test consisted of putting the helmets on a dummy head containing accelerometers and dropping it, neck-side up, from various heights onto a metal platform. The head form was tilted at two different angles, simulating hits to the crown and the side of the head. Researchers dropped the helmets from as low as 0.8 meters to as high as two meters and measured the linear acceleration of the helmet as it struck the

ground.

A crucial caveat

Camarillo said that the large size of the air bag helmet compared to foam bike helmets is the likely source of its success. Being larger, it can also be softer, allowing for a more cushioned fall. However, this cushioning also has a potential downside. In the testing, the air bag helmet was pre-inflated and the researchers maximized the pressure of the air inside the helmet before each drop in order to get these results.

"As our paper suggests, although air bag helmets have the potential to reduce the acceleration levels that you experience during a bicycle accident, it also suggests that the initial pressure that your air bag helmet has is very critical in reducing these acceleration levels," Kurt said.

Without the maximum amount of air, the air bag helmet could bottom out, causing the head to hit the ground with much more force than if it were wearing a traditional foam helmet. In current versions of the air bag helmet, a chemical process triggers expansion, which doesn't seem to guarantee maximum air pressure.

Linear acceleration and concussion

In this study the researchers measured linear acceleration of a head upon impact, which can tell us about risk of skull fracture and head injury. It does not directly relate to risk for concussion. Concussion is a rapidly evolving area of research but experts currently think that concussion may be related to angular stretching of the brain, which is more likely caused by a twisting motion rather than linear motion.

"There are many theories as to why concussion happens, but the predominant one is that, as your head rotates very quickly, the soft tissue

within your brain contorts and, essentially, what you get is a stretching of the axons, which are the wiring of the brain," Camarillo said.

The drop test used in this study is currently the standard test for bicycle helmets. Although testing the abilities of the helmets to reduce rotational forces would better tell us how they could protect against concussion, Camarillo said that, given the large advantage of the air bag helmet in this research, there is a good chance it would reduce the likelihood of concussion compared to a foam helmet.

Better helmet testing

The air bag helmet is not available in the United States but is sold in some European countries. It's a relatively new innovation and, by comparison, helmet standards and testing are very far behind.

"If our research and that of others begins to provide more and more evidence that this air bag approach might be significantly more effective, there will be some major challenges in the U.S. to legally have a device available to the public," Camarillo said.

Even for conventional foam helmets, the standard testing doesn't address some elements that science indicates matter when it comes to brain injury and head trauma, including assessment of rotational forces and drop tests of parts of the helmet other than the crown. The air bag helmet would raise additional testing issues, including the fact that helmets are generally tested on a head dummy without a neck, which couldn't wear the air bag helmet.

Future air bag helmet research

Next steps for the air bag helmet include testing how it affects rotational

accelerations and forces on the head during impact and how the helmet could reduce tissue-level strains in the brain. The researchers also want to more closely investigate the bottoming out weakness of this helmet type, dropping it from greater heights and seeing how this air cushioning holds up.

It's also their intention to work at making this helmet smarter. It already expands when it senses a likely impact but they want it to be able to predict the severity of the impact and compensate accordingly.

More information: Mehmet Kurt et al. Modeling and Optimization of Airbag Helmets for Preventing Head Injuries in Bicycling, *Annals of Biomedical Engineering* (2016). DOI: 10.1007/s10439-016-1732-1

Provided by Stanford University