Defense Health Agency

Defense and Veterans Brain Injury Center "Clinical Updates in Brain Injury Science Today [CUBIST]" Podcast

"Can You Get a Brain Injury from Riding a Roller Coaster?"

Episode 108, Transcript

Release Date: September 11, 2017

TRT: 8:13 min

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Anne Bunner: The views, opinions, and findings contained in this podcast are those of the host and subject matter experts. They should not be construed as official Department of Defense positions, policies or decisions unless designated by other official documentation.

Hi. Welcome to Clinical Updates in Brain Injury Science Today, or CUBIST, a biweekly podcast for health care providers about current research on traumatic brain injury, also known as TBI. This program is produced by the Defense and Veterans Brain Injury Center, otherwise known as DVBIC. And I'm your host, Anne Bunner, filling in today for our regular host, Inbal Eshel. I'm a biologist and program analyst here at DVBIC. You may remember me from previous episodes of CUBIST, where I frequently joined Inbal to talk about TBI research making headlines. In today's episode, I'll be talking with Dr. Don Marion. Dr. Marion is a neurosurgeon and senior clinical consultant at DVBIC. In today's episode, Don and I will discuss a study entitled, "Pilot Findings of Brain Displacements and Deformations During Roller Coaster Rides." This article was recently published in the Journal of Neurotrauma by Kuo, K-U-O, and colleagues. Welcome, Don.

Don Marion: Thank you, Ann.

Anne Bunner: So tell us, why did the researchers choose to investigate roller coasters?

Don Marion: Previously, there have been several case studies reporting serious brain injuries from roller coaster rides including seven cases of subdural hematomas, two cases of subarachnoid hemorrhage, and multiple cases of concussion. However, none of these previous studies carefully looked at brain displacement and deformation during roller coaster rides.

Anne Bunner: So when you talk about these cases of severe or even mild injuries with roller coasters, are we talking about cases where the roller coasters malfunction and these people were struck in the head?

Don Marion: No, and that's the interesting aspect in what these investigators are trying to get at. In all of these cases I mentioned, there was no direct contact with the head.

Anne Bunner: So who were the subjects in this study?

Don Marion: So these individuals looked at two healthy 26-year-old men who were of slightly different size and slightly different diameter or circumference of their necks, which is related to some points we'll make later on. These two individuals underwent three roller coaster rides where, Anne, they sat next to each other on the roller coasters. For comparison, they also ran three miles at about a nine-minute-per-mile pace. And then one of the subjects was also a participant in a soccer heading trial using a ball launcher.

Anne Bunner: So how did they measure their head movements during these activities?

Don Marion: The men wore a custom-fitted mouth guard that was tightly fitted to their upper dentition. Each mouth

guard had a triaxial accelerometer and triaxial gyroscope embedded into it, which recorded acceleration and velocity in three dimensions. This data was then transferred to a computer-based engineering model to calculate kinematics and estimations of brain displacement and brain deformation and strain.

Anne Bunner: So what did they find?

Don Marion: The maximum brain surface displacements were four millimeters and the maximum principal strain was approximately 7.6 percent during the roller coaster rides, which was similar to soccer headers but less than with running. And I emphasize that. I think that's important. Strain is the elongation of compression of tissue relative to the original length of that tissue. And many investigators feel that axonal injury or so-called diffuse axonal injury is related to strain. So that's kind of an important issue. The individual variation among the two men though should be emphasized. So for one of the men, the roller coaster angle of velocity exceeded average soccer header velocity only once but for the other subject, it exceeded average soccer header angular velocity 21 times. So there's quite a significant difference in that parameter.

Anne Bunner: So what do you think accounted for the differences between the results from the two subjects?

Don Marion: Again, as I alluded to at the beginning of the talk, I think the one subject had a greater mass and larger neck circumference, and that was the individual who only had one angular velocity that exceeded the soccer headers.

Anne Bunner: So what are some of the limitations of this study?

Don Marion: The primary limitation, in my opinion at least, is that the deformation and strain values were not directly measured, but were estimated from computer simulations and finite element modeling. It's really not possible to validate their models for all possible conditions. Of course, an additional limitation is that there were only two subjects in the study.

Anne Bunner: What is your takeaway message for providers from this paper?

Don Marion: I think that during roller coaster rides, Anne, the average brain displacements and strain levels appear to be lower than those in mild sports head impacts, and likely present a low risk of acute brain injuries. However, the peak brain displacements and strains during these rides are higher than everyday activities and comparable to mild sports activities such as soccer heading. Angular velocity, in particular, can be double that seen in soccer heading. So ultimately, if multiple subconcussive brain displacements or strains are thought to be associated with long-term cognitive problems, as some have suggested, then longitudinal studies of frequent roller coaster rides might be needed.

Anne Bunner: Does publicizing research like this risk alarming patients and providers about something innocuous when there are many more concussions sustained in activities like ball sports and cycling?

Don Marion: Sure it does, Anne, and I think that's a great point. I think that we have to be very careful about alarming people about things like roller coaster rides. I don't believe that this article establishes that roller coaster rides cause serious brain injury or even over the long term are necessarily risky behavior. But I do think this article does suggest that we do need good long-term longitudinal studies.

Anne Bunner: Thank you so much, Don, for your insights. That's all we have time for today. We hope you enjoyed this quick literature update. You can stay up-to-date on future episodes by subscribing to CUBIST on iTunes, Stitcher, or wherever you listen to podcasts, where you can also find links to the articles we discuss and other relevant resources. Speaking of relevant resources, myself and the deputy director of DVBIC, Ms. Kathy Helmick, will be giving a free webinar on gender differences in TBI outcomes on Tuesday, September 19th at 11:00 AM Eastern Time. This is part of a three-day continuing education summit featuring almost 30 expert speakers on a variety of issues related to TBI and psychological health. To register, go to dvbic.dcoe.mil, and click on the banner that says, 2017 Summit, Register Now. That's D-V-B-I-C, dot D-C-O-E, dot M-I-L. If you have any questions about the podcast or about DVBIC products or programs, or if you have feedback for us, please feel free to email us at info@dvbic.org. That's I-N-F-O, at D-V-B-I-C, dot O-R-G.

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CUBIST is produced and edited by Deborah Bailin and was hosted today by me, Anne Bunner. It is a product of the Defense and Veterans Brain Injury Center, led by Acting National Director Dr. Thomas DeGraba, and the Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury, led by Acting Director Dr. Richard Stoltz. Thank you for listening. We'll be back in two weeks to explore TBI research that has received significant media attention.

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