Editorial

Leather football helmets

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At the request of the editor we are providing this editorial to Rowson et al.’s “Biomechanical performance of leather and modern football helmets. Technical note.” In their paper, Rowson et al. have attempted to provide additional data and insight to clarify certain conclusions reported in an earlier American football helmet study by Bartsch et al.1

In the real world, American football collisions always involve combinations of linear and rotational motion that may pose risk to the participant’s short-term and long-term brain health. When Rowson et al.’s rigid drop tests are contrasted with Bartsch et al.’s common “on-field” laboratory impacts, it is of utmost importance to consider the testing methodologies and head motions induced.

Rowson et al. drop-tested helmets against a rigid surface with infinite mass and stiffness under standard conditions.4 These standard drop tests allowed mainly linear head motion and benchmarked skull fracture risk. Their data showed that modern helmets, which are designed to perform under these standardized testing conditions, performed significantly better than leather helmets. A real-world analogy to these results is that one’s skull would be significantly better protected when running headfirst into a brick wall while wearing a modern American football helmet versus a vintage leather helmet.

In contrast, Bartsch et al. tested a helmeted head form striking a second helmeted head form that was mounted on a flexible neck, permitting linear and rotational head motion. These laboratory tests represented an approximation of two players colliding headfirst while wearing modern and vintage helmets under common on-field conditions that could induce skull, brain, and neck loading. Bartsch et al.’s data demonstrated that in these common on-field impact scenarios, modern and vintage leather helmets frequently protected the skull and brain comparably. The two studies used disparate methodologies, examined different injury risk metrics, and hence produced divergent results. Therefore, Rowson et al.’s additional data do not clarify the limitations of, but rather stand in contrast to, the data presented in Bartsch et al.’s study.

Rowson et al. are correct in recharacterizing the conclusions of Bartsch et al.’s experiments by stating “leather helmets performed similarly to modern helmets when struck by a Riddell VSR4 helmet….” However, even with this recharacterization, the resulting differences between the studies reported by Rowson et al. and by Bartsch et al. provide ample motivation to reassess the rigid drop test standard. These differences also suggest the need to continue physics-based helmet performance investigations under on-field conditions that induce linear and rotational head motion. Furthermore, Rowson et al. as well as others have recently published on-field impact data2,3,6 validating the fact that Bartsch et al.’s “on-field” laboratory impact conditions generated linear and rotational head motions similar to those commonly occurring in the real world. It is emphasized that these common linear and rotational real-world head motions have now been conclusively proven to be markedly different from Rowson et al.’s drop test head motions.

We now have two studies—by Rowson et al. and by Bartsch et al.—that provide dissimilar results in spite of apparent similarities in head forms, helmets, impact energy, and impact momenta. The difference in results can be conclusively explained by the two very different testing methodologies used and the head motions induced. We also can conclude that not all impact tests are created equal. Therefore, we must continue examining experimental protocols to achieve better quantification of helmet performance under conditions in which on-field physics testing methodologies and relevant injury risk metrics are considered.

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Disclosure
The authors report no conflict of interest.

References


Response

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We thank Bartsch et al. for their commentary on our technical note. Our purpose was to offer additional data by using a different testing methodology that could offer insight as to how leather football helmets could perform similarly to modern football helmets. Our contrasting results offer an explanation through our differing impact conditions. Specifically, we wanted to draw attention to the effect that a compliant impactor can have on comparisons of relative helmet performance. While our biomechanical assessment can be found in our technical note, we aim to highlight several points with this response.

First, we agree with Bartsch et al. that laboratory testing should be representative of impacts that players experience on the field. We have developed laboratory testing methods that evaluate relative helmet performance based on our 10 years of on-field head impact data. From these data, we understand the head impact exposure (defined as the cumulative frequency, location, and acceleration magnitude of impacts) of the collegiate football player. We generalize and emulate head impact exposure with 20 laboratory testing conditions in our Summation of Tests for the Analysis of Risk (STAR) evaluation system.

Second, not all helmets are created equal in their ability to reduce concussion risk. Head acceleration magnitude is correlated to concussion, and is a good predictor of injury with high sensitivity. Helmets that modulate the impact energy transfer so that peak head acceleration is lower reduce concussion risk. Concussion risk reduction estimated by the STAR evaluation system is supported by clinical on-field data quantifying concussion risk exposure.

We are in the process of refining the STAR evaluation system to reflect this based on our on-field measurements of linear and rotational head acceleration.

Experimental testing conditions should be considered when interpreting data. Overall, modern helmets are vastly superior to leather helmets; we and Bartsch et al. agree on that. As we continue to advance our understanding of head impacts in football as well as our understanding of human tolerance, additional progress can be made on improving helmet design criteria aimed at reducing concussion risk.

References


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