Bicycle Helmet Efficacy with Magnesium and Hybrid III Headforms

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Abstract

Cycling is popular for transportation and leisure. Bike helmets are used to mitigate the risk of head injury in collisions or falls. According to NHTSA, 52,000 cyclists were injured in the US in 2010. Head injuries accounted for two thirds of hospital admissions, among cyclists. Despite strong epidemiological evidence of efficacy, some researchers and many lay people argue that bicycle helmets do not lower the head injury risk in bicycle crashes and falls. One definitive data set that would contribute to this debate is largely missing and that is biomechanical tests of helmeted vs. unhelmeted head impacts. This is because bicycle helmet standards specify magnesium headforms and unhelmeted impacts are not possible with these headforms. Therefore it was our objective to establish the Hybrid III headform as a valid device for evaluating bicycle helmet effectiveness by comparing it to a magnesium headform in impacts with contemporary bicycle helmets. The HIII head was also used in helmeted and unhelmeted tests to investigate bicycle helmet effectiveness. A monorail drop tower was used to create drops from 0.5 m to 3.0 m in 0.5 m increments. Eight drops were performed using a helmeted magnesium headform and 16 were performed using a HIII headform (8 helmeted/8 unhelmeted). Linear head acceleration, Head Injury Criterion (HIC) and Injury Assessment Reference Values (IARV) for AIS 4+ brain injury were used to compare helmeted to unhelmeted head impacts. The magnesium headform peak head accelerations and HIC values were 5% and 9% higher than HIII respectively. The average of the peak head accelerations for helmeted impacts was 4.2 times lower with HIC values 6.8 times lower than the unhelmeted impacts. The HIII headform was found to reproduce the magnesium headform's response within an acceptable margin. Bicycle helmets were highly effective at mitigating and preventing injury in these tests.