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IMPROVING BACK PROTECTORS EVALUATION : TOWARDS A MORE REALISTIC CERTIFICATION APPROACH ?

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Powerful two-wheeler (PTW) riders are 30 times more likely to be involved in an accident than car drivers. To mitigate injury risks, back protectors (BP) have been developed, offering abrasion and impact protection for the back. These devices are certified under EN 1621:2 standard, which quantifies the force a BP must absorb under vertical impact by a road-type impactor. However, limited data exists on real-world back impact conditions and the effectiveness of BPs in such scenarios.
This study aims to identify realistic impact conditions and injury mechanisms leading to spinal injury in motorcyclist and compare them with the current back protection testing standards.

First, a dedicated survey on motorcycle accidents focusing on crash scenarios and fall mechanisms was conducted, gathering responses from 947 injured riders. Rider profiles (age, sex, protections gear, motorcycle type, etc.), crash scenarios (solo fall, vehicle collision, obstacle impact, etc.), fall kinematics (tumbling, side fall, back fall, etc.), and injury types (affected body parts, bone fractures, skin injuries, etc.) were analyzed. Second, a finite element human model (THUMS V5) was used to reconstruct a typical impact condition leading to spinal injury. The simulated impact involved a back fall with high normal and angular velocities (2.3 m/s and -6 rad/s), replicating the tumbling mechanism described in the survey. Spinal injury risk was assessed using Von Mises stress analysis and cortical and cancellous bone failure thresholds.

Among 947 survey responses, 62 reported a spinal injury (6.5 %) with 24 (58.3 %) sustaining injuries after ejection-tumbling. Moreover, 14 (52.3 %) of them were wearing a BP. Other spinal injuries were primarily caused by side impacts and direct back impacts. FEM simulations revealed spinal hyperflexion induced by a contact point on L5. T8's transverse process fractured from direct impact (cancellous bone failure at 5.2 MPa), while T4 failed due to flexion. In cortical bone, stress propagated from T8 to T4, but no clear failure was observed (failure threshold: 180 MPa).

Early survey data confirmed that spinal injuries often result from hyperflexion due to ejection-tumbling, aligning with initial FEM simulation results. These findings emphasize the need to incorporate such impact conditions into back protector safety evaluations, as they are not addressed by current certification standards.