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Proposed Algorithms to Assess Concussion Potential in Rear-End Motor Vehicle Collisions: A Meta-Analysis

Authors : Rami Hashish, Manon Limousis-Gayda, Caitlin McCleery

Abstract : Introduction: Mild traumatic brain injuries, also referred to as concussions, represent an increasing burden to society. Due to limited objective diagnostic measures, concussions are diagnosed by assessing subjective symptoms, often leading to disputes to their presence. Common biomechanical measures associated with concussion are high linear and/or angular acceleration to the head. With regards to linear acceleration, approximately 80g's has previously been shown to equate with a 50% probability of concussion. Motor vehicle collisions (MVCs) are a leading cause of concussion, due to high head accelerations experienced. The change in velocity (delta-V) of a vehicle in an MVC is an established metric for impact severity. As acceleration is the rate of delta-V with respect to time, the purpose of this paper is to determine the relation between delta-V (and occupant parameters) with linear head acceleration. Methods: A meta-analysis was conducted for manuscripts collected using the following keywords: head acceleration, concussion, brain injury, head kinematics, delta-V, change in velocity, motor vehicle collision, and rear-end. Ultimately, 280 studies were surveyed, 14 of which fulfilled the inclusion criteria as studies investigating the human response to impacts, reporting head acceleration, and delta-V of the occupant's vehicle. Statistical analysis was conducted with SPSS and R. The best fit line analysis allowed for an initial understanding of the relation between head acceleration and delta-V. To further investigate the effect of occupant parameters on head acceleration, a quadratic model and a full linear mixed model was developed. Results: From the 14 selected studies, 139 crashes were analyzed with head accelerations and delta-V values ranging from 0.6 to 17.2g and 1.3 to 11.1 km/h, respectively. Initial analysis indicated that the best line of fit (Model 1) was defined as Head Acceleration = 0.465

Keywords : acceleration, brain injury, change in velocity, Delta-V, TBI
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