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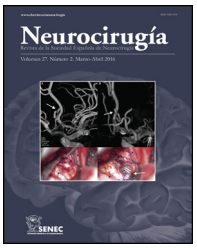

Special article

Pedestrian head injury biomechanics and damage mechanism. Pedestrian protection automotive regulation assessment☆

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ABSTRACT

Introduction: Pedestrian–vehicle collisions are a leading cause of death among motor vehicle accidents. Recently, pedestrian injury research has been increased, mostly due to the implementation of European and Japanese regulations. This research presents an analysis of the main head injury vehicle sources and injury mechanisms observed in the field, posteriorly the data are compared with the current pedestrian regulations.

Methods: The analysis has been performed through an epidemiologic transversal and descriptive study, using the Pedestrian Crash Data Study (PCDS) involving 552 pedestrians, sustaining a total of 4500 documented injuries.

Results: According to this research, the hood surface is responsible for only 15.1% of all the head injuries. On the other hand, the windshield glazing is responsible for 41.8%. In case of sedan vehicles the head impact location exceeds what is expected in the current regulation, and therefore no countermeasures are applied. From all the head injuries sustained by the pedestrians just 20% have the linear acceleration as isolated injury mechanism, 40% of the injuries are due to rotational acceleration.

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Conclusions: In this research, the importance of the rotational acceleration as injury mechanism, in case of pedestrian–vehicle collision is highlighted. In the current pedestrian regulation just the linear acceleration is addressed in the main injury criteria used for head injury prediction.

Biomecánica y mecanismo de producción del traumatismo cráneo-encefálico en el peatón atropellado. Evaluación de la normativa actual en la automoción

Palabras clave:
Biomecánica
Protección de peatones
Traumatismo cráneo-encefálico
Atropello
Aceleración rotacional

RESUMEN

Introducción: Los atropellos son una de las principales causas de muerte entre los accidentes de tráfico. Recientemente, ha aumentado el estudio de los atropellos, principalmente debido a la aplicación de la normativa europea y japonesa en protección de peatones. Esta investigación presenta un análisis del traumatismo cráneo-encefálico del peatón atropellado, asociándolo con la estructura del vehículo responsable de la lesión, su mecanismo de daño y comparando el resultado con la normativa existente.

Métodos: La metodología empleada ha consistido en un estudio epidemiológico descriptivo y transversal, mediante el estudio de datos de peatones atropellados recogidos en la base de datos americana (PCDS) que analiza a un total de 552 peatones atropellados y un total de 4.500 lesiones documentadas.

Resultados: De acuerdo con este estudio, el capó es el causante del 15,1% de las lesiones de la cabeza del peatón, mientras que el parabrisas es responsable de 41,8% de todas las lesiones. En el caso de los vehículos tipo utilitario la ubicación del impacto de la cabeza se produce por encima de lo que se espera en la regulación actual y, por lo tanto, no se aplican las contramedidas necesarias. De todas las lesiones en la cabeza sufridas por los peatones solo el 20% tiene la aceleración lineal como mecanismo de lesión, el 40% de las lesiones se deben a la aceleración rotacional.

Conclusiones: En esta investigación se pone de manifiesto la importancia de la aceleración rotacional como mecanismo de daño en la cabeza del peatón atropellado. En la normativa actual solo la aceleración lineal está contemplada en la formulación del principal criterio biomecánico utilizado para predecir el traumatismo cráneo-encefálico.

Introduction

Traumatic brain injuries (TBIs) are presented in scientific literature as one of the main injuries to pedestrians in accidents.[1–4] Additional studies have shown that head and neck injuries suffered by pedestrians represent almost 60% of all injuries to pedestrians in accidents.[5]

In an effort to reduce the risk of head injuries to pedestrians who are hit by cars, researchers have developed several tools, such as head impactors, pedestrian dummies and computer models. These tools have helped to increase the biomechanical knowledge of a collision during an accident. It has been observed that the local stiffness of the structures of vehicles is a primary concern in reducing the risk of a head injury and that simulations of impacts with mannequin pedestrians and computer models enable us to test other factors that affect the risks of TBI, such as the geometry of the vehicle and its influence on the angle and speed of the impact to the head with the vehicle.[6]

At present, it is a requirement to pass experimental tests in order to sell a new vehicle in Europe and Japan (EC 78/2009, TRIAS 63-2004). Other very influential consumer tests, such as EuroNCAP include the pedestrian test in order to evaluate vehicles' overall safety. The purpose of this study is to examine this regulation; evaluating the pedestrian's head protection in the event of a collision. This research presents an analysis of primary head injury mechanisms, sources of injury observed in field studies and their comparison with current regulations. The location of the impact to the pedestrian's head on the vehicle and the collision distance is measured by wrap around distance (WAD). The head injury mechanism for pedestrians will be contrasted with the biomechanical criteria used in current regulations.