

Development of an Occupant Protection Seat Concept for Mitigating Whiplash Injuries in Rear-End Impacts

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Whiplash injuries are widely believed to result from non-physiological head–neck kinematics, particularly the so-called S-shaped deformation that occurs during the early phase of rear-end collisions. This abnormal motion can induce irreversible damage to cervical soft tissues. Typical symptoms include headache, dizziness, and nausea; however, such symptoms are often difficult to diagnose objectively because clear clinical findings are frequently absent. Consequently, the precise mechanisms underlying whiplash injury remain poorly understood, and effective preventive measures have yet to be fully established.

In the present study, to better reflect human neuromuscular characteristics, a custom control algorithm incorporating muscle co-contraction was implemented, thereby enhancing both the stability and responsiveness of the head–neck complex to externally applied loads and disturbances. These methodological advancements provide a foundation for future analyses aimed at optimizing headrest design parameters.