A New Instrumentation Technique for the Cervical Spine of PMHS in Rear Impacts

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ABSTRACT

A newly developed technique to place instrumentation on the anterior aspect of the bodies of the cervical vertebrae and the first thoracic vertebra was proposed to measure detailed neck kinematics in rear impact tests. The instrumentation technique is capable of measuring kinematics at each vertebral level from the second cervical vertebra (C2) to the first thoracic vertebra (T1), while minimizing damage to the neck muscles and soft tissues. The first cervical vertebra (C1) was not instrumented because the anterior aspect of the C1 vertebral body is too small to install the instrumentation. Lab trial tests were conducted using post mortem human subjects (PMHS) in a rigid rolling chair to simulate 10 km/h rear impact events. Three accelerometers and three angular rate sensors were installed at each of the seven vertebrae (C2 – T1) to measure the translational (x- & z-direction) and angular (y- direction) displacements of the cervical vertebrae during the event . Steinman pins with fiducials were embedded in each vertebral body to record kinematics using a high speed camera (1000 Hz), for comparison with data from the proposed instrumentation (20 kHz). All instrumentation blocks including the fiducials were digitized using a FARO arm, and local coordinates systems were created on each block to measure the initial Euler angles used for transformation of the local coordinates to the global (lab) coordinate system. Results from the lab trials show that our proposed technique is capable of accurately measuring detailed neck kinematics during rear impact tests. The next phase of this study is to test PMHS in rear impact sled test conditions to quantify not only the detailed cervical kinematics, but also to generate data which can be used to assess the internal and external biofidelity of the existing rear impact dummies utilizing the NHTSA Biofidelity Ranking System.