
Analysis of Human Test Subject Kinematic Responses to Low Velocity Rear End Impacts

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ABSTRACT

The head, neck and trunk kinematic responses of four volunteer test subjects, recorded during a series of experimental low velocity motor vehicle collisions, have been measured and analyzed. Using data obtained from multiple high speed film, video and electronic accelerometer measurements of the test subjects, it was found that the actual kinematic responses of the human head, neck and trunk that occur during low velocity rearend collisions are more complex than previously thought. Our findings indicate that the time-honored description of the cervical "whiplash" response is both incomplete and inaccurate.

Although the classic "whiplash" neck response to rearend collisions and the widely accepted hyperextension/hyperflexion cervical injury mechanism have been extensively written and speculated about, there have been little human experimental data available, especially for low velocity collisions. Low velocity collisions are defined in this report as motor vehicle collisions in which the impact related change of the rearended vehicle's velocity (ΔV) is about 12.9 kph (8 mph) or less. Throughout nearly 4 decades of experimental crash testing, low velocity mishaps (as defined above) have been felt to have a minor injury causation potential and have remained a relatively unstudied area. The absence of good experimental data, accurately defining real occupant kinematic response during this common type of traffic accident has spawned a plethora of divergent concepts, ideas and speculation about possible injury mechanisms.

In February 1991, a series of vehicle collision tests using fully instrumented volunteer human test subject/drivers and a Hybrid III manikin passenger was conducted, utilizing local testing facilities. This project was undertaken to better define human, dummy and vehicle responses during low velocity collisions.

METHODS

VEHICLES — Four test vehicles, a 1986 Dodge 600 convertible, a 1984 Buick Regal Limited coupe, a 1984 Ford Club Wagon van and a 1984 GMC 1500 pickup truck were prepared for the test protocol. Each vehicle was without evidence of collision structural damage and was in roadworthy condition with factory standard equipment and parts. The convertible and coupe had factory standard energy absorber bumper systems, and the truck and van bumper systems were rigidly mounted to the vehicle frame structure. Although each vehicle remained in stock condition to the maximum extent possible, the testing protocol required a number of modifications. The test subjects had to be photographically accessible, so the upper portion of the Ford van's left B-pillar and the front doors of each vehicle were removed. The rear window of the pickup truck was replaced with a small Lexan panel, and headrests in the convertible and the coupe were kept in the raised position. Several mounting points for high speed cameras were installed on each vehicle. Each vehicle's original, factory standard 3-point restraint system was used throughout the tests. Vehicles were checked prior to testing and any bumper assembly damage found was repaired with new parts.

TEST SUBJECTS — The proposed test protocol was evaluated by the University of Texas Health Science Center Institutional Review Board and IRB Protocol #9010099006 of the University of Texas Health Science Center, under DHHS Regulation 46.110(3), approved the use of four human test subjects selected from the staff of Biodynamic Research Corporation in the test series. Four healthy volunteer male test subjects, ranging in age from 45 to 56, completed pre-testing physical evaluations including radiographic imaging studies of the cervical, thoracic and lumbar regions of their spines. Test subject marking for photographic analysis included a stiff "U" shaped yellow rod attached to an individually fitted biteblock and accelerometer assembly and oriented rearward on both sides parallel to the aluminum strip connecting the accelerometers and the closed