C42 Low Velocity Rear-Impact Evaluation of Seat Strength and Headrest Performance Related to Neck Injury Risk

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The goals of this presentation are to present an experimental method and results for objective side-by-side measurement and comparison of motor vehicle seat strength and headrest performance as related to low velocity rear-impact neck injury risk factors for various size occupants subjected to whiplash rear-impact levels of approximately 13 KPH.

This presentation will impact the forensic community and/or humanity by providing a more accurate and scientific means for evaluating vehicle seat strength and headrest performance as related to low velocity (whiplash) neck injury risk measures. As a result of the side-by-side comparison testing, it is concluded that increased seat strength and stiffness are not the likely factors leading to reported increased cases of whiplash cited in other recent studies.

Some recent automotive studies, conducted by automotive industry researchers, have suggested that, during rear-impact, the more common, but weaker, single-recliner (SR) seat designs (i.e. about 3.2 kN strong), which tend to collapse rearward during moderate to severe rear impacts, provide improved occupant protection over the much stronger and available "belt-integrated" seat (BIS) designs (i.e. about 14.5 kN strong), for impact severities ranging from low velocity "whiplash" levels (i.e., 15 kph or less) on up to more severe rear impacts of 40 to 50 KPH. It has also been hypothesized in these studies that, because seat designs have been getting stronger since the early to mid 1990s, stronger seat designs, like the BIS types, may actually be the cause of an increase seen in current numbers of "whiplash" neck injury cases. While it may be true that there are more cases of whiplash being seen today in contrast to the 1980s and earlier, there are a number of other factors beside seat strength and stiffness which may influence the rise in whiplash claims. For instance, an increased number of larger vehicles, such as sport utility and pick-up vehicles have populated the urban and rural highways since the late 1980 time frame. These types of vehicles are more aggressive, and larger, than most economy sized family sedans and minivans, and as such they offer another potential source for contributing to an increase in whiplash injury cases. However, in light of the above industry suggestion that stronger seats are the cause of increased whiplash cases, the current study focuses on scientifically examining the seat strength and headrest performance issue.

In order to better understand the effects of seat strength and headrest performance as they relate to low velocity change (i.e., 13 kph) rear-impact whiplash situations, the current study uses an experimental, side-by-side, scientific test method and protocol (presented by the authors at the 57th Annual Meeting of the AAFS) to evaluate neck injury risk of weaker SR seat designs compared to stronger BIS designs, for various sizes of Hybrid III surrogates (i.e., a 50 kg small 5th%tile female, a 80 kg average 50th%tile male, and a average male surrogate ballasted to 110 kg) seated in a stationary sled-buck system that is impacted by a moving non-deformable sled traveling at 25 KPH. A deformable barrier is mounted to the stationary sled-buck system and provides an 8 G, 80 millisecond crash pulse similar to that recommended by the NHTSA (National Highway Traffic Safety Administration) for analyzing "whiplash" effects. Neck injury performance is based on the "percent risk of AIS (Abbreviated Injury Scale) 3+ injury" derived from the NHTSA combined load "Nij" values, calculated from the measured surrogate response.

A typical 4-door family sedan vehicle, with full interior, was used as the baseline vehicle. The driver seat position utilized the weaker SR seat design, and the right front seat position utilized the stronger BIS design. A total of six sled-buck tests were run at a low "whiplash" severity level (13 KPH). Three tests were run for the small, medium, and large surrogates with the seat headrests in the "full down" position, and another 3 tests were run to examine the effects of the headrests in the "full up" position for all 3 sizes of surrogates. Each surrogate was instrumented with head, upper neck, lower neck, and chest instrumentation. In all cases the surrogates were leaned forward "out- of-position" (OOP) from the headrests with a gap of 5 inches, to examine effects of occupants in non-optimum seating positions for both seat types (SR and BIS).

The data and results of the "side-by-side" seat tests are summarized in several tables. Included in each table is a category for "% Risk of AIS 3+ Neck Injury Potential." What the results indicate is that for case of the headrests in the "full up" position, there is no significant difference between the neck injury risks of either the SR or BIS seat designs for all sizes of surrogates, and in both seat types there is no significant risk of neck injury. On the other hand, with the headrests in the more common "full down" position, the weaker SR seat demonstrated higher risk of neck injury for the average and large size occupants, but slightly lower risk for the small female surrogate. None of the values, however, indicated a severe risk of neck injury. As a result of the side-by-side study it is concluded that increased seat strength and stiffness are not the likely factors leading to the increased cases of whiplash injury cited in the recent automotive researchers studies mentioned above. Thus, it is recommended that additional scientific studies be conducted to look at other

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"whiplash" factors such as vehicle size and aggressivity parameters.

Rear-Impact, Whiplash, Seat Strength

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