



Impact direction effect on serious-to-fatal injuries among drivers in near-side collisions according to impact location: Focus on thoracic injuries

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ABSTRACT

Occupant injury in real world vehicle accidents can be significantly affected by a set of crash characteristics, of which impact direction and impact location (or damage location) in general scale interval (e.g., frontal impact is frequently defined as general damage to vehicle frontal end with impact angle range of 11–1 o'clock) have been identified to associate with injury outcome. The effects of crash configuration in more specific scale of interval on the injury characteristics have not been adequately investigated. This paper presents a statistical analysis to investigate the combined effects of specific impact directions and impact locations on the serious-to-fatal injuries of driver occupants involved in near-side collisions using crash data from National Automotive Sampling System-Crashworthiness Data System (NASS-CDS) for the calendar years of 1995–2005.

The screened injury dataset is categorized by three impact locations (side front, side center and side distributed) and two impact directions (oblique impact at 10 o'clock and pure lateral impact at 9 o'clock), resulting in six crash configurations in total. The weighted counts and the risks of different types of injuries in each subgroup are calculated, with which the relative risks along with 95% confidence intervals under oblique impacts versus lateral impacts in each impact location category are computed. Accordingly, the most frequent injury patterns, the risks and the coded-sources of serious thoracic injuries in different crash configurations are identified. The approach adopted in the present study provides new perspectives into occupant injury outcomes and associated mechanism. Results of the analyses reveal the importance of consideration of the crash configurations beyond the scope of existing side-impact regulatory tests and stress the necessity of vehicle crashworthiness and restraint system design in omni-direction to better protect occupants in real-world crash scenarios.

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1. Introduction

Near-side impacts are one of the most severe crash modes with high frequency in real traffic accidents, commonly resulting in serious occupant disability and death. In 2006, up to 70% of total fatalities in side impact crashes are caused by near-side impacts (NHTSA, 2006). Compared with far-side impacts, near-side collisions are 2.3 times more common (Haland et al., 1993). Statistics showed that vehicle-to-vehicle near side impacts account for up to 75% of side impact crashes resulting in serious-to-fatal injuries (Augenstein, 2000). Near-side occupants, adjacent to the side of the vehicle subjected to major impact, are found more frequently to sustain severe injuries than far-side occupants, due to considerably limited survival space on the struck side. It was reported that 60% of total injuries and 67% of serious injuries are to near-side occupants in side impact crashes (Stolinski et al., 1998;

Digges et al., 2005). As a result, protection of near-side occupants is the top priority in side collisions.

A variety of crash-related factors could influence the patterns and severity of injuries sustained by near-side occupants Terrel et al. (2003), including vehicle speed before crash, change of impact velocity (delta-V), impact direction and impact location. Emphasis has been primarily placed on the investigation of the effects from impact severity and general crash configuration (front impact, side impact, rear impact, etc.) on the injury outcomes (Hillary et al., 1999; Arndt and Grzebieta, 2003; Augenstein et al., 2003; Laberge-Nadeau et al., 2009; Sunnevang et al., 2009; Viano and Parenteau, 2010). For instance, most previous field data statistical analyses often simply classify the sample data with general deformation in vehicle side as well as impact angles ranging from 8 to 10 o'clock into side impact category. Very few studies, to the best knowledge of the authors, address the relationship between the injury characteristics for the most often seriously injured body regions and the crash configurations defined by the impact direction and impact location in more specific scale interval.

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