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Lateral impact injuries with side airbag deployments—A descriptive study

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Abstract

The present study was designed to provide descriptive data on side impact injuries in vehicles equipped with side airbags using the United States National Automotive Sampling System (NASS). The database was queried with the constraint that all vehicles must adhere to the Federal Motor Vehicle Safety Standards FMVSS 214, injured occupants be in the front outboard seats with no rollovers or ejections, and side impacts airbags be deployed in lateral crashes. Out of the 7812 crashes in the 1997–2004 weighted NASS files, $AIS \ge 2$ level injuries occurred to 5071 occupants. There were 3828 cases of torso-only airbags, 955 cases of torso-head bag combination, and 288 inflatable tubular structure/curtain systems. Side airbags were not attributed to be the cause of head or chest injury to any occupant at this level of severity. The predominance of torso-only airbags followed by torso-head airbag combination reflected vehicle model years and changing technology. Head and chest injuries were coupled for the vast majority of occupants with injuries to more than one body region. Comparing literature data for side impacts without side airbag deployments, the presence of a side airbag decreased AIS = 2 head, chest, and extremity injuries when examining raw data incidence rates. Although this is the first study to adopt strict inclusion-exclusion criteria for side crashes with side airbag deployments, future studies are needed to assess side airbag efficacy using datasets such as matched-pair occupants in side impacts. © 2006 Elsevier Ltd. All rights reserved.

Keywords: Lateral impact; Side airbags; Head and chest injuries; Descriptive study

1. Introduction

Airbags are used in modern motor vehicles for enhancing occupant safety during impact. Frontal airbags have been in the vehicle fleet for over a decade, and the United States federal requirements are promulgated through Safety Standards FMVSS 208 (NHTSA, 2005). In contrast, side airbags are more recent than frontal airbags and are intended to primarily protect the occupant during lateral crashes. They are installed as thorax or torso-only airbag, torso-head airbag (combination airbags), or separate torso and head airbags (inflatable tubular structure or curtain). Although federal regulations do not exist in the United States for side airbags, such systems are gaining popularity because of public awareness for safety and their potential injury mitigating characteristics (NHTSA, 1999, 2003). While many studies are conducted to investigate injuries

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in frontal impacts with frontal airbags, no such systematic evaluations of side impacts with side airbags have been published, to the best knowledge of the authors (Pintar et al., 2000). Only a few studies have begun to appear in the literature with no unified conclusions on side airbag responses. McGwin et al. (2003) used the United States National Automotive Sampling System (NASS) database for the years 1997–2000 to determine the association between side airbags and risk of injury in motor vehicle collisions with near-side impact. The authors assumed that all vehicles with side airbags as optional equipment were equipped with the technology and concluded that vehicles with side airbags had a risk of injury similar to occupants of vehicles without side airbags. This assumption is a major limitation of the study, and its validity was not discussed. Using NASS database for the year 2000, another study conducted an analysis of 187 occupants with airbag deployments out of which 62 were in side impacts (Bazarian et al., 2004). Although this study concluded that side airbags may be effective in preventing cranial trauma, less than 1% of occupants were in vehicles equipped with side airbags. These analyses, albeit brief, indicate the need to conduct a more detailed study specific to side airbag deployments. Therefore, the purpose of the present investigation is to focus

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on a descriptive case series of lateral impact-induced injuries in vehicles with side airbag deployments.

2. Methods

The NASS database was interrogated with the constraint that all vehicles adhere to the Federal Motor Vehicle Safety Standards, FMVSS 214. Case selection criteria was such that the occupant should be involved in a side impact collision with the principal direction of force between 50° and 130° for passengers, and 230° and 310° for drivers, and the primary impact should be in the lateral direction resulting in deployment of a side airbag. All types of airbag systems, i.e. torso alone, side or head curtain or inflatable tubular structure, or a combination of torso and side curtain or head, were included. Other selection criteria included passenger cars, light trucks, and vans. Only outboard front seat occupants, driver and passenger, were included in the study. Rollovers and full ejection events were excluded. The 1990 version of the Abbreviated Injury Scale was used (AIS, 1990) for injury coding. Briefly, the grading system for injury levels is as follows: (0) no injury; (1) minor; (2) moderate; (3) serious; (4) severe; (5) critical; (6) maximum; (7) unknown. Body regions represented the head, face, neck, chest, abdomen, spine, and upper and lower extremities. In addition, the source of injury and confidence in injury assignments was extracted from caseby-case description of injuries in the database. The sourcing of injuries is a separate variable in NASS. The assignment of the injury source and the confidence levels are done by specialists at the Zone center responsible for quality controlling the work of the field investigator that documented the crash. The confidence levels are initially indicated by the field investigator, but these are subject to correction by the specialists at the Zone center. AIS = 1 level data are presented to a limited extent, and since they are less clinically significant, descriptions are limited to occupants sustaining AIS ≥ 2 injuries. Weighted data are included in the results and discussion.

3. Results

NASS data for the years 1997–2004 were used in the study. With the inclusion–exclusion criteria specified earlier, a total of 7812 side crashes had impact-related injuries (all AIS levels). The actual number of sampled cases was 68. Of the 7812 crashes, 7214 were left and 598 were right side impacts. Lap and shoulder belts were used by 7346 occupants, and no belt restraints were used by the remaining 466 occupants. Limiting the analysis to AIS \geq 2 injuries, 4572 crashes occurred to the left side, and 499 crashes occurred to the right side, for a total of 5071 impacts. When data were categorized based on airbag type, there were 3828 cases of torso only airbags, 955 cases of torso-head bag combination, and 288 inflatable tubular structure/curtain systems. Regarding the location, 4724 airbags deployed from the seat, 237 from the door and roof side rail, 59 from the door, 49 from the roof side rail, and nine from the seat back and roof side rail.

Table 1 provides a summary of raw and weighted data based on AIS level and body region. As discussed later, one raw data

Number of occupants sustaining injuries as a function of body region

AIS 1 174 3 Lo40 18 223 5 179 3 246 6 354 5 467 AIS 2 441 10 47 3 179 3 246 6 354 5 467 AIS 3 401 6 47 4 4 4 163 388 AIS 4 315 4 4 4 4 163 163 AIS 5 42 1 4 4 132 2 163 AIS 6 42 1 3 9 1 9 1 AIS 6 42 1 3 6 141 4 1 163 AIS 7 42 1 3 6 141 4 1 163 AIS 7 209 1 3 7 9 1 1	AIS level	Head		Face		Neck		Chest		Abdomen		Spine		Up extremities	ties	Low extremities	nities
174 3 1040 18 223 5 179 3 246 6 352 5 441 10 47 378 6 141 4 5 401 6 47 378 6 141 4 132 2 315 4 1 61 3 9 1 42 1 61 3 9 1 84 1 318 3		Weighted	Raw data	Weighted	Weighted Raw data	Weighted Raw data	Raw data										
441 10 3237 6 3042 6 522 5 401 6 47 378 6 141 4 7 315 4 288 6 132 2 42 1 61 3 9 1 84 1 318 3 9 1	AIS 1	174	3	1040	18	223	5	179	3	246	9	354	5	467	13	3321	10
401 6 47 378 6 141 4 315 4 132 2 42 1 61 3 9 1 84 1 318 3 209 1 318 3	AIS 2	441	10					3237	9	3042	9	522	5	388	∞	652	10
315 4 288 6 42 1 61 3 84 1 318 3	AIS 3	401	9	47				378	9	141	4			163	1	336	11
42 1 61 3 84 1 318 3 209 1 318 3	AIS 4	315	4					288	9			132	2				
84 1 209 1	AIS 5	42	1					61	3			6	1				
209 1	AIS 6	84	1														
	AIS 7	209	1					318	3								

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