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Relative risk of spinal cord injury in road crashes involving seriously injured occupants of light passenger vehicles

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Abstract

Road crashes involving occupants of light passenger vehicles are the leading cause of traumatic spinal cord injury (SCI). Confirming the results of an earlier study, this study showed that: in single vehicle car crashes in the country, the odds of SCI were nearly five times higher (4.7) for occupants of non-sedan type light passenger vehicles compared with sedans; in single vehicle rollover crashes in the country, the odds of SCI were nearly three times higher (2.8) in non-sedans compared with sedans; the odds of SCI were nearly five times higher (4.8) for sports utility vehicles (SUVs) compared with sedans. When the data from the earlier study was included in order to increase statistical power, it was found that when compared to sedans that did not roll, occupants of all types of light passenger vehicles had a statistically significant substantially higher likelihood of SCI when involved in rollover (sedans 7.5 times, SUVs 5.9 times and others 8.4 times). In addition, SUVs had a higher likelihood of SCI even when not involved in rollover (5.4 times). Vehicle designers and regulators need to give more attention to the prevention of vehicle rollover and the means to improve occupant protection in the event of rollover. This study should be extended nationally to gain a larger case series so that the SCI risk of particular vehicle configurations, considering other crash factors, can be more precisely quantified and characteristics for low occurrence of SCI identified.

Keywords: Spinal cord injury; Risk factors; Sports utility vehicles; Rollover; Single vehicle crashes

1. Introduction

Motor vehicle crashes are the leading cause of traumatic spinal cord injury (SCI), accounting for 43% of cases in Australia (O'Connor, 2000) and 45% in the USA (Go et al., 1995). The majority of people who sustain an SCI in a motor vehicle crash are occupants of light passenger vehicles: 75% in Australia (O'Connor, 2002) and 82% in the USA (Thurman et al., 1995). In these crashes the cervical segments of the spine are most frequently damaged, resulting in tetraplegia (Fife and Kraus, 1986; Thurman et al., 1995).

Most of the studies investigating SCI related crashes have found that single vehicle crashes are more common than multiple vehicle crashes (Taylor, 1995; Thurman et al., 1995; McPherson and Simpson, 1977) and also that SCI commonly occurs in vehicle rollover (Huelke et al., 1981; Kraus et al., 1982; Cushman et al., 1991; Toscano, 1987; Wigglesworth, 1991; Thurman et al., 1995). Thurman et al. (1995) found that 85% of vehicle rollovers resulting in SCI were single vehicle crashes.

These results were based almost exclusively on descriptive studies of SCI case reports without reference to any comparison group. The absence of a comparison group meant that is was not possible to exclude the possibility that SCI was a low frequency random event in serious injury crashes and also that the high frequency of the putative SCI risk factors indicated by descriptive studies might reflect nothing more than the high frequency of these events among serious injury cases generally.

The first case–control study of the factors for SCI in crashes involving light passenger vehicles was undertaken recently in South Australia (O'Connor, 2002). It showed that in single vehicle crashes in the country, the likelihood of SCI was five times higher for occupants of non-sedan type light passenger vehicles compared with sedan type light passenger vehicles. The likelihood of SCI was also high in non-sedan type light passenger vehicles involved in rollover crashes. Unfortunately, the South Australian SCI case series was too small to demonstrate the particular non-sedan type light passenger vehicles that were more highly involved in SCI.

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Based on an assessment of sample size issues from the South Australian study it was suggested that extension of the study to Victoria should provide the required case numbers for at least a partial assessment of the contribution of specific non-sedan type light passenger vehicle, such as four wheel driver passenger and utility vehicles (in the USA these are referred to as sports utility vehicles: SUVs). This report concerns the Victorian extension of the South Australian study and incorporates Victorian specific results as well as results from the aggregation of the two state data where relevant.

2. Study aim

The aim of the study was to compare the characteristics of light passenger type vehicles (i.e. sedans, station wagons, passenger vans, four wheel drive passenger vehicles, four wheel drive utility vehicles and other utilities, but excluding trucks and motorcycles), in which an occupant received an SCI, with light passenger type vehicles in which an occupant was otherwise seriously injured.

The Victorian study covers the period 1987–2002. It is an extension of an earlier South Australian study based on SCI cases incident in the period 1988–2000, results of part of which have been published (O'Connor, 2002).

3. Methods

The inclusion criteria for the study were: (a) the crash occurred in Victoria over the period 1987–2002, (b) the crash resulted in the admission to hospital of a light passenger vehicle driver or passenger aged 15 years or older, and (c) the crash did not result in the death of any of these occupants within the period of 30 days from the crash event.

The SCI case data were provided by the Austin Hospital ($n = 161$). This was sourced through the Australian Spinal Cord Injury Register (ASCIR), developed by the first author in association with the second author and the Director's of the other Australian spinal treatment units. The coverage of the ASCIR has been verified as complete for all cases aged 15 years and over that did not die prior to admission to one of the six specialist SCI treatment hospitals (O'Connor, 2004).

The characteristics of light passenger vehicle crashes involving SCI were compared with all other Police reported light passenger vehicle crashes that occurred in Victoria in which an occupant aged 15 years or older was admitted to hospital, but in which no occupant died within 30 days ($n = 52{,}646$). There was no direct means to control for crash impact severity. The comparison group were all crashes in which someone was seriously injured, but there was no data available on injury severity among hospitalisations because there were no data linkages between Police crash reports and hospital data in Victoria. Exclusion of cases that died within 30 days of the crash was designed to remove the potential for confounding of the results on the basis of injury severity, following the general advice of Rothman and Greenland (1998, p. 144–145).

The selection of exposure variables and potential confounders for the study was guided by the literature search that formed the basis of the previous study by O'Connor (2002) and also by a consideration of qualities of the VicRoads data.

In common with the crash reporting systems in other Australian States, the Victorian VicRoads crash database is constructed on information provided to Police via incident report forms, generally completed by those involved in the crash. In Victoria, crashes resulting in personal injury or property damage must be reported to Police. As a consequence of self-reporting, it is well known that some data items are unreliable. For example, people will rarely admit to speeding or failing to wear a seat belt. In addition, most will not know the characteristics of the road at the site of the crash, nor technical details of the vehicle that they are driving at the time. Self-reporting of injury severity is also unreliable. These limitations impose constraints on a study such as the present one, restricting available data items to those considered reliable. Information on seat belt wearing and speed was not considered reliable and was excluded from the analysis.

Light passenger type vehicles were classified into three groups: sedans (which included vehicles that seated only two passengers), sports utility vehicles (SUVs, which included four-wheel drive passenger vehicles and four-wheel drive utility vehicles), and other light passenger vehicles (i.e. passenger vans, station wagons and other utility vehicles). The neurological level and completeness of damage to the spinal cord were defined at admission rather than discharge, according to the motor index scores of the American Spinal Injury Association (Maynard et al., 1997), to remove the potential for the results to be affected by demographically related biases in recovery, for example by age, as has been found by Cifu et al. (1999).

VicRoads crash data, based on Police reports, was suitable for determining the characteristics of the crash and injured person. The location of the crash was categorised as either city or country on the basis of information provided by VicRoads. The city referent group (Melbourne) was defined so that it would be comparable with the circumstances of crashes occurring in any medium to large city internationally, enhancing the external validity of the findings. The country group was substantially rural crashes (72%), with the remainder involving crashes, in or around, small towns and hamlets (3%) small provincial cities (9%) and other towns and cities (16%). In consideration of statistical power, the country group was not further subdivided.

In order to assess the specific vehicle types involved in SCI and other serious injury crashes it was necessary to determine the vehicle identification number (VIN) of each crashed vehicle. The Police crash reports did not record the VIN, but this could be obtained from the motor registration branch of VicRoads, via the vehicle registration number. The registration numbers of the vehicles in which a person suffered a SCI and a random sample of vehicles involved in other serious injury crashes (approx. five controls for each SCI case), were referred to VicRoads so as to determine the VIN. As VINs were not recorded substantially until 1989, the assessment of the contribution of vehicle type was restricted to 1989 onwards. Once the VIN was obtained, the vehicle characteristics were determined with reference to the 'New vehicle data'