

### Accident reconstruction of some uncommon spinal injuries in auto-crashes in the Kingdom of Saudi Arabia

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During the period of January 2004 to March 2008, a prospective study was conducted to obtain detailed collision characteristics of spinal injuries in Riyadh, Kingdom of Saudi Arabia. The objective of the study was used to obtain detailed collision characteristics of spinal injuries in Kingdom of Saudi Arabia.

The data was received from collaborators in injury prevention, including police and fire departments, emergency medical services, and trauma centers based in the city of Riyadh. This method was considered the most efficient approach to collect accurate and timely data on the mechanisms of spinal injury resulting from Motor Vehicle Crashes (MVCs). All casualties with spinal injury who involved in MVC and admitted to the Emergency Department (ED) of the major hospitals of Riyadh were included in this study. For each crash, accidental details and site conditions were obtained from the traffic police accident reports, evidence and observations of the police officers, or witnesses. Two yards, police impound yards, and crash-involved parties from Najm Project for Motor Insurance Development were contacted to obtain permission to inspect vehicles, to determine vehicle damage, and crash dynamics. Information regarding the history of each vehicle involved in the sample was supplied by the General Directorate of Traffic and Motor Vehicle Periodic Inspection Programme.

The first aids conditions were extracted from the emergency reports by the Saudi Red Crescent Society and ED at each hospital. The corresponding medical details of casualty were obtained from the medical records of trauma centers in the main hospital where the casualty admitted in. Additional crash data was obtained from the Alriyadh Development Authority database. In some cases, additional evidence was obtained from casualty's contacts, police officers, or witness's interviews. During the study period, there were 512 car collisions involving 978 vehicles occurred in Riyadh, Saudi Arabia in which casualties sustained at least one spinal injury with severity of AIS  $\geq 2$ . In this study, information on 778 spinal injuries sustained by 552 casualties in 512 vehicle crashes met the selection criteria for this study. These cases were reconstructed and simulated using PC-Crash™.

This incident took place in July 2006 in the evening, in Al-Kharj province, South of Riyadh. A 44-year-old male driver was driving a 4-door 1995 BMW-730i se (1878 kg) westbound at a high speed ( $\approx 155$  km/hour) in the first lane of a divided two-way road. The road was unlit. The driver appeared to lose control and struck a light pole with a Principal Direction of Force (PDOF) of 110 degrees. The driver's side of the car struck the pole with a collision deformation classification estimated to be 10LPAN4. The total delta-V of the impact was estimated to be 125 km/hour. The pole was damaged and sheared at its mounting and fell on to the car. The trapped driver was extricated by bystanders before the vehicle ignited and became engulfed in flames. The damage to the vehicle consisted of a broken windshield, separation of the door skin, a buckled A-pillar, intrusion of the driver side door, and the right side of the roof over the driver was depressed into the occupant compartment.

In this particular crash one car and fixed objects were involved. The simulation was developed with a car (BMW, 1555 kg) going straight (west bound) at a speed of 155 km/h. Many variations in the scenario were simulated. One of the scenarios that matched the result reasonably well was when the car orientation just before impact was  $9^{\circ}$  with the right shoulder. Finally, the car struck a light pole (which was on the divider) with a PDOF of  $110^{\circ}$ . This reconstructed simulation matches well with the known impact positions and kinematics.

A physical examination revealed mild tenderness over the driver's forehead and the left side of his neck. Nonetheless, a lateral radiography and multi-detector CT scan of the cervical spine showed a cleft between the superior and inferior facets of the articular pillar of cervical (C)6 and grade I spondylolisthesis at C6 anteriorly with respect to C7. In addition, he also sustained serious injuries to other body parts (Table 1).

The diagnosis of spinal injury was confirmed to be a bilateral cervical spondylolysis. The probable sources of these injuries are indicated in Table 1. Examination of the vehicle interior showed that there was evidence of occupant contact on the left side sun visor. The fracture injury to the cervical vertebra is likely to have occurred as a result of either forced extension or flexion of the cervical spine due to head contact with the A pillar. Such type of loading can occur with an impact to the top of the head, and the force being directed along the neck.

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**Table 1** - Injuries of driver.

Injury	ISS body region	AIS	Source of injury
Brain mild contusion	Head	150202.3	A pillar
Soft tissue bruising over right vertex	Head	110402.1	A pillar
Bilateral C6 cervical spondylolysis	Cervical spine	650222.3	A pillar
3 linear abrasions on left cheek	Face	210202.1	A pillar
Bruising lower lip	Face	210402.1	A pillar
Laceration of forehead	Face	210600.1	Windshield
Multiple abrasions over right lateral chest	Thorax	410202.1	Side door
Multiple ribs fractures posteriorly	Thorax	450264.4	Side door
Transverse fracture through sternum	Thorax	450804.2	Side door
Extensive lacerations of parietal pleura	Thorax	441802.3	Side door
Bilateral lung contusions	Thorax	441410.4	Side door
Multiple abrasions over right flank	Abdomen	510202.1	Side door
Multiple fractures of pelvis	Extremities	852608.4	Steering wheel
Displaced fracture of right femur	Extremities	851815.3	Steering wheel

Injury severity score (ISS) was 41. AIS - injury scale

The rarity of this condition means the natural course of cervical spondylolysis has not been well described. The spondylolisthesis is usually grade I and less than 3mm.<sup>1</sup> The common mechanisms of this type of spinal injury were described by many authors.<sup>2</sup>

In this typical vehicle crash with uncommon spinal injuries was reconstructed, and the kinematics was correlated with injury information to develop confidence on the analysis of the mechanisms of injuries in these crashes. Haddon's matrix was used to present intervention measures for different stages of the impact. Since these crashes are typical crashes in Saudi Arabia, they demonstrate the ability of the methodology to handle all kinds of crashes and also to give suggestions of these injuries can be prevented in future.

The case studied was a side impact struck with a light pole. The spinal injury of the driver was identified as a bilateral cervical spondylolysis. One of the outcomes of fixed object collisions may be the resulting injuries sustained by the occupants of the vehicles. The severity of injury can be ameliorated or the accidents even eliminated by introducing highway safety measures.<sup>3</sup>

In conclusion, cervical spondylolysis has radiological features. Recognition of the anomaly and differentiating it from acute cervical fracture or dislocation is important in casualties with recent neck injuries. The primary cause of the spinal injury in this case was the head impacting with either the A-pillar or the light pole. This injury could have been prevented or greatly reduced had the driver been wearing a seatbelt and had the vehicle design included side airbags.<sup>4</sup>

All health care professionals and emergency staff can be involved in primary prevention activities (namely, educational programs, awareness campaigns, and legislative campaigning). This is the most important level of prevention and the most effective in decreasing the rate of preventable spinal injury in Kingdom of Saudi Arabia.

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