Motor vehicle collisions with large animals

Masoud O. Bashir, *MS, FRCSI,* ***Fikri M. Abu-Zidan,*** *PhD, DipApplStats.*

ABSTRACT

Motor vehicle collisions (MVC) with large animals are a worldwide problem. In this review, we aim to analyze the mechanisms and patterns of human injuries caused by MVC with large animals and various ways to prevent them. Reported studies on large animals that can cause such accidents include the moose, camels, deer, and kangaroos. The moose causes a typical rear-and downward deformity of the roof of the car. The camel falls on the roof of the car causing cervical and head injury to the occupants. Injuries caused by kangaroos and deer are usually mild. Injuries may be caused by direct collision with the animal or hitting another object when trying to avoid it. Alarming signs, underpasses or overpasses for animals, and reflectors that frighten the animals were all used to prevent the collisions. Roo-bars are used in Australia to reduce the car damage when hit by a kangaroo. Fencing has proven useful in United Arab Emirates. The mechanism of injury varies with the size and height of the animal and can be serious. Increased awareness of the effects of collision with large animals and ways to reduce it has to be promoted.

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Motor vehicle collisions (MVC) with large animals occur in areas where these animals reside. They are a major cause of vehicle collisions on the roadways in USA.[1] Most of these collisions occur in rural areas.[2] Moose are mainly found in north Europe, Asia and North America. Camels inhabit the Middle East, Asia, North Africa, and Australia. Kangaroos live in Australia. Adult moose may stand over 1.8 m and weigh up to 550 kg.[3,4] Camels are long-limbed animal standing approximately 2 m at the shoulders and weigh up to 600 kg.[5-7] Kangaroos are big-footed marsupials, and stand 2 m high and carry a weight of up to 90 kg.[8] Vehicle accidents involving deer have occurred for decades, probably since the advent of the automobile.[9] They constitute 85% of motor vehicle collisions with large animals in the USA.[1,2] Such accidents usually result in deer kills, with a low human morbidity and mortality.[10] The reported cases of accidents with large animals vary considerably (**Table 1**). In Sweden and North America, MVCs with moose are common.[3,4,11,12] On the other hand, there are few reports of camel and kangaroo related injuries.[5,8,13] The aim of this review is to analyze the mechanisms and patterns of human injuries caused by MVC with large animals and various ways to prevent them. MEDLINE search on MVCs with large animals was performed. Further articles were retrieved from the references of the original articles. Data of published articles were descriptively summarized and compared.

Behavior of the animal and mechanism of injury. ***Camels.*** Camels are usually domesticated but occasionally may move around unsupervised in herds.[5] They may come into highways without warning (**Figure 1**). Car collision against camels occurs at twilight, in the early morning or at the end of the day.[14,15] When the car strikes a camel, it falls on the roof above the front seat (**Figure 2**) or destroys the front of the windscreen hitting the passengers.[5,13,15] As the passenger flexes his body to avoid the injury, the occiput and cervical spine sustain the impact dorsally.

From the Department of Surgery (Bashir), Al-Rhahba Hospital, Abu-Dhabi, and Department of Surgery (Abu-Zidan), Faculty of Medicine and Health Sciences, United Arab Emirates University, Al-Ain, *United Arab Emirates*.

Address correspondence and reprint request to: Dr. Fikri M. Abu-Zidan, Department of Surgery, Faculty of Medicine and Health Sciences, PO Box 17666, Al-Ain, *United Arab Emirates*. Tel. +971 (3) 7137579. Fax. +971 (3) 7672067. E-mail: fabuzidan@uaeu.ac.ae

Table 1 - Reported studies of motor-vehicle collisions with large animals.

Authors	Year	Reference number	Country	Animal	Number of cases
Williams and Wells	2005	2	USA	Mainly deer (77%)	147
Centers for Disease Control and Prevention	2004	1	USA	Mainly deer (87%)	676
Abu-Zidan et al	2002	8	Australia	Kangaroo	46
Ansari et al	2001	13	Saudi Arabia	Camel	3
Ansari et al	1998	15	Saudi Arabia	Camel	39
Al-Sebai and Al-Zahrani	1997	5	Saudi Arabia	Camel	16
Farrell et al	1996	4	USA	Moose	696
Rattey and Turner	1991	11	Canada	Moose	661
Bjornstig et al	1991	16	Sweden	Moose	40
Ljungren et al	1990	7	United Arab Emirates	Camel	3
Bjornstig et al	1986	3	Sweden	Moose	650

Figure 1 - Camels crossing Al-Fujaira Highway (United Arab Emirates). (Photographed by Abu-Zidan)

Figure 2 - A-Pillars and front roof of a car which were injured by a camel falling on the roof after being hit by the car. (Courtesy: Professor Norbert Nowotny, Department of Medical Microbiology, Faculty of Medicine and Health Sciences, UAE University, Al-Ain, UAE)

The resulting vertical force causes compression fractures of the spine (**Figure 3**). The passenger may alternatively bend laterally to avoid direct impact of the camel coming through the windscreen. These different forces may act on the spine and result in flexion-extension, rotational or horizontal compression injuries.[5,13,15]

Moose. The moose moves seasonally looking for food. In the spring and early summer, moose crave sodium from aquatic plants located adjacent to deiced roadways. The moose population is increased around the roads at this time. A male moose can be dangerous during the breeding season due to their increased activity that peaks at dawn and dusk.[4] Accidents with moose increase during the summer and fall and in the first few hours after sunrise and sunset. The height of the moose from the ground to the under surface of its abdomen is generally higher than the hood of a small car. The victims of MVC with a moose sustain injuries by 2 mechanisms, a direct primary collision with the animal or an indirect secondary collision when the driver tries to avoid the animal and hits another object.[3,16] The moose might fall on the roof, windshield or the A-pillars. The A-pillars are the front pillars at the sides of the windshield. They are usually bent rearwards and downwards, the roof pressed backwards and down, while the front and hood stay fairly undamaged. The severity of the occupant injury is related to the degree of deformity of the vehicle.[3] The inclination of the windshield at a sharp angle and the deformity of the roof will be dangerously close to the heads of the front seat occupants causing severe head injuries (**Figure 4**).

Deer. Motor vehicle collisions with deer are common in North America. Even though large numbers of deer-vehicle collisions occur annually, it

Figure 3 - A 26 years old male was involved in a car collision with a camel. The camel fell on the roof and caused a compression fracture of the second cervical spine (C2) and the third thoracic spine (T3). He became paraplegic due to the burst fracture of the third thoracic spine.

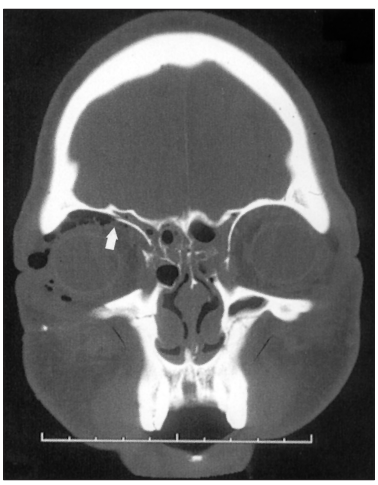

Figure 4 - An adult male who was involved with a collision of a moose at Umea, Sweden. He sustained midface fractures. Fractures are seen at orbital wall (arrow), ethmoid and maxillary bones. (Courtesy: Dr M. Sjostrom, Department of Maxillofacial Surgery, Umea University, Sweden).

Figure 5 - A kangaroo killed on the roads of Western Australia, Perth. (Photographed by Abu-Zidan)

is difficult to prove their cause.[17] High vehicle speed is considered one of the main causes. Up to 200 fatalities per year results from collision with large animals in USA.[1,18] The majority of these are due to collision with deer.[2] In the last 25 years, deer motor vehicle collisions have increased from 5-15.5% of all collisions in USA.[19] Large number of collisions occurs in the fall and early winter with peak occurring in mid-November. There are 2 peaks during the day, at sunrise and 2 hours after sunset.[10,20] Highway characteristics influence areas of deer-vehicle collisions. More than 90% of collisions occur in rural roads mainly on 2-lane paved roads.[10,19] Inability to see in front and on the sides while driving my contribute to collisions with deer.[21]

Kangaroos. The kangaroo is a big-footed animal. Its tail helps it to balance when hopping. The kangaroo's speed may be more than 60 km/hr. A kangaroo moves forward and jumps upward. It has difficulty moving backwards due to the shape of its legs and bulky tail, so it has a limited maneuverability when facing a fast moving car. Kangaroos usually shelter under the shade during the day and graze at evening. Most of the accidents happen during the night. Drivers are usually taken by surprise when a kangaroo suddenly jumps in front of them and have insufficient distance or time to avoid the kangaroo. The vehicle either rolls over or struck another object when trying to avoid the collision. Abu-Zidan et al[8] have reported 40% of primary collision and 35% secondary collision.[8] The transmission of energy when hitting a fixed object (like a tree) increases the severity of injuries. Kangaroo-related MVCs are less common during winter. The seasonal variation might be related to increased movement of animals when searching for food, increased population of the animals, and possibly increased number of rural road users during the summer. Water accumulates beside the paved roads after raining which makes grass grow on the side of the roads attracting kangaroos. Motor-vehicle collisions with kangaroos are mostly fatal to the latter (**Figure 5**). Humans sustain relatively minor injuries.[8]

Distribution of injuries. The majority of human injuries caused by motor vehicle animal collisions are mild; mostly sprains, contusions and abrasions. They mainly involve the head, face, neck and upper trunk. Only 6% of non fatal injuries treated at Emergency Departments at USA needed hospitalization.[1] These were predominantly due to deer-related collisions. The unusual axial-load when a camel falls on the roof of a car may cause severe spinal cord injuries with permanent neurological deficits.[5] Car collisions with

moose, however, constitutes major hazards to drivers. Bjornstig et al[3] reported 650 patients who were involved in a direct moose-car collision. Of these 54% had injuries to their head and neck, 38% had upper extremities injuries. Other series reported 70-87% head and face injuries, and 26% cervical spine injuries.[4,11] Collisions with kangaroos have similar distribution of injuries where more than 65% of them occur to the head, face and neck.[8]

Prevention. It is essential to follow the general rules in reducing road traffic injuries. Certain risk factors increase these injuries. These include, driving above the speed limits, lack of use of safety seat belts and helmets, drinking alcohol while riding, and using hand held mobile phones. Both law enforcement and public education have to be implemented to reduce these risk factors.[22,23] Farrell et al,[4] using a logistic model, has shown that seat belt use and rear seat occupancy have a significant protective effect. Sixty-five percent of motorcyclists killed in vehicle-animal collisions were not wearing helmets, and 60% of vehicle occupants were not wearing seatbelts. Using safety devices could have reduced the death toll of these collisions.[2] Approximately 40% of vehicle-animal collisions in USA involved unprotected vehicles such as motorcycles.[2] Eighty percent of motorcycle-deer collisions resulted in injury or death to the motorcyclist.[19]

Furthermore, we have to consider specific methods to prevent MVC with large animals. These include 1. reduction of the agent of harm (presence of animals on the roads), 2. Improvement of the conditions of the environment (road safety engineering), and finally 3. reduction of the occupant's severity of injury if collisions occur. Isolation of the agent of harm (animals) by fencing has been used to reduce collisions with moose, deer, and camels. It is an effective measure for preventing collisions with large animals along short sections of highways such as critical high-kill areas. We have recently observed in the United Arab Emirates the dramatic drop of camel MVCs after fencing hundreds of kilometers of highways between major cities. Nevertheless, this is an expensive solution for long distances.[21,24] Fences must be of proper height and should be inspected and repaired frequently. Animals continuously test the fences which makes a good maintenance program necessary. If the animals are trapped between the road and fence, then adequate one way gates should be available.[17] However, some animals are reluctant to use them. Alternate routes for the animals to cross these highways have to be provided. This includes underpasses and overpasses.[25] The visual appearance of underpasses can affect their acceptance by the animals.[17,21] Effectiveness of underpasses for large animals depends on the distance between them. Underpasses should be located where wildlife naturally cross roads.[26] Overpasses can be used effectively when combined with fencing. They should have a reasonable width and must be covered with dirt and grass. Nevertheless, animals prefer underpasses. Underpasses are usually more expensive.[17,26] The crosswalk system guides animals to cross at specific areas. This helps motorists to anticipate and avoid the animals. Crosswalks were found to reduce collisions by almost 40%.[27] They should be designed in a way that does not disrupt free movement of animals within their environment. Road side mirrors and reflectors were tried to prevent animals from approaching the road when vehicles are present assuming that animals will stop when they see a reflected red light. The value of reflectors is not yet proven. They do not affect the behavior of the animals and animals adapt to them quickly.[17] Ultrasonographic noise makers were used to frighten kangaroos and deer but, they were not successful.[17,24,28] The use of biological natural auditory signals like the foot thump of kangaroos seems to be more promising to deter animals from the roads.[28] Animal crossing signs are commonly used to prevent collisions with animals. Motorists, especially those who travel frequently, usually disregard them.[24] Moving signs placed in high risk areas during high risk times may modify the behavior of motorists. Motorists should respect the speed limits, especially at night, in areas of large animal population.[20] In countries where camels are the causative agents, their breeding sites should be kept away from the highways. The owners of these camels should be penalized for letting their camels roam free along the main roads. Modification of the vehicle structure may help to reduce injuries caused by collision with large animals. This may include seatbelts and airbags, strengthening of the A-pillars and roof and the use of safe windshields that have an inner protective plastic layer.[3] Some cars in Australia are fitted with bars (such as "Roo-bars") to protect against kangaroos, but these may be dangerous to passengers as they tend to cause more pelvic injuries. At present, fencing seems to be the most effective way that can reduce collision with large animals.[17] Furthermore, advances of automobile detection technology are promising.[29]

In summary, the mechanism of human injury varies with the size, build and height of the large animal that collides with their vehicle. Although the majority of these human injuries are mild, some are serious and life threatening. Increased awareness of the effects of collision with large animals and ways to reduce it has to be promoted.

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