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A review of large animal vehicle accidents with special focus on Arabian camels

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ABSTRACT

Traffic accidents resulting from the collision of motor vehicles with wildlife occur worldwide. In the United States, Canada, Europe, the Middle East and Australia these collisions usually involve deer, moose, camels and kangaroos. Because these are large animals, the collisions are frequently associated with high morbidity and mortality rates. Camel-vehicle collisions in the Middle East—especially Saudi Arabia—have risen to such disturbing proportions that definitive action is necessary for mitigating the trend. Arabian camels, weighing up to 726 kg, form a crucial part of the socio-cultural experience in Saudi Arabia, where about half a million of them are found. Saudi Arabia presents a case of habitat fragmentation, especially in rural communities, where good road systems coexist with domesticated camels. This environment has made camel-vehicle collisions inevitable, and in 2004 alone two hundred such cases were reported. Injuries are directly related to the size of the camel, the speed of the vehicle, passengers' use or avoidance of seat belts, and the protective reflex movements taken to avoid collision. Cervical and dorsal spinal injuries, especially fractured discs, head and chest injuries, are the most commonly reported injuries, and the fatality rate is four times higher than for other causes of traffic accidents. Various mitigation measures are considered in the present work, including measures to improve driver's visibility; the construction of highway fencing; under- and over-passes allowing free movement of camels; the use of reflective warning signs, and awareness programs.

Key words: Wildlife-vehicle collision, large animal, traffic accident, trauma, emergency, Arabian camels, Saudi Arabia, road safety, Middle East

INTRODUCTION

In 2004 alone, about 700 wildlife-vehicle collisions (WVCs) were reported in the United State of America with collisions involving deer constituting the largest proportion.[1-2] While such cases mostly involved high mortality rates among deer and not humans [3] the picture changes drastically when larger animals such as kangaroos, moose and, especially, camels are involved. The incidence of WVC is reportedly high in regions where these animals are found and usually results in loss of human lives as well as damaged property—both natural and man-made. The associated damage and mechanism of injury generally varies with species, and a comprehensive understanding of such particularities will help in designing measures for the prevention of WVCs. While the different types of WVCs are examined in the present work, particular attention has been accorded collisions involving Arabian camels whose sociocultural and geographical positioning deserve special treatment.

Instances of WVCs have been reported in almost all parts of the globe but they are of greatest significance in regions where they represent a sizeable proportion of annual auto accidents. The incidence of WVCs is closely tied with the natural distribution and behavioral pattern of the concerned animals: deer (North America, Canada and Europe), kangaroos (Australia), moose (North America and Canada) and camels (North Africa and Mid-East countries) being the most prominent examples.[1-2] Between 70 and 90 % of all cases of WVCs in North America involve deer, [2, 4] where excessive speeding on the part of the drivers was suggested as the primary cause. [5] In the US, 247,000 deer-vehicle collisions (DVCs) took place in 2000 resulting in 200 human fatalities, $1.1bn in property damage and a significant decline in the deer population.[4] An estimated $3bn was also reportedly incurred by governments, insurance agencies and drivers.[6] The increasing population of the white-tailed deer, most commonly involved in DVCs, combined with traffic expansion and increased traffic volume on roads situated close to 'deer-populated forestry'[7-10] have been identified as factors increasing the incidence of DVCs in the United States.[11]

An adult moose with a typical body weight of about 550 kg[12-13] constitutes greater danger to the occupants of cars involved in collisions than does a deer. With an average height of 1.8 meters, the underbelly of an adult moose easily towers over an average car's hood.[14] This animal's height dictates a high center of mass, which means that a collision would result in the animal falling on and through the poorly reinforced frontal section of the car's upper surface (roof and windshield), usually with severe consequences to the occupants of the front seat.[9, 15] In the period covering 1995 to 2000, 5,721 combined cases of deer-moose vehicle collisions were reported in the New Brunswick area of Canada. Of these cases, 26% involved moose and resulted in 20 out of 21 human fatalities and 57% of the total injuries.[9,16] In Sweden, 4,092 vehicle collisions with moose were reported in 2005 alone, a figure generally believed to be much lower than the actual number.[17-18] Collisions with moose were reported to constitute, in this same time period, 60% of all road accidents according to the Swedish National Road Administration (SNRA). Even though less than 5% of human casualties were reported in these collisions, the fatality figure was quite the opposite for the involved animals, with 92 out of 100 moose and 98 out of every 100 deer reportedly killed in these accidents.[17-18]

Collisions involving camels are somewhat different in certain respects, including an increased severity of associated injuries (mortality and morbidity), geographic distribution, and the sociocultural value of camels—especially domesticated—as important aspects of the culture within which they are found. For this last reason, the loss of a camel's life in WVC is not only a loss to wildlife but also a loss of the utility value attached to these pack animals.

There are two species of camels, both of which are domesticated (apart from the camelids of South America: llama, guanaco, vicuna and alpacia): the larger Arabian camel (also known as dromedary) and the two-humped Bactrian camels found in the Gobi desert of China.[19-20] There are about 14 million camels worldwide, 500,000 of which were reported to move freely in Saudi Arabia where in certain places they attain population densities as high as six camels per ten square kilometers[21-22] and 12 camels per kilometer stretch of the highway. This high population makes WVCs with camels almost unavoidable. An increase of 150% in the population of camels in the United Arab Emirates was reported over a period of four decades.[23] This camel population increase, when combined with increasing urbanization and construction of rural roads and highways in desert areas (the natural habitat of the camels), presents a unique case of habitat fragmentation and a major cause of motor accidents on Saudi roads.

MECHANISMS AND PATTERNS OF WVC INJURIES

In 1998 at the Riyadh Armed Forces Hospital in Saudi Arabia a study was conducted on patients admitted with low cervical spine injuries, and 85 out of 100 cases were said to result from motor vehicle accidents. Collisions involving camels were identified as a major cause of accidents on the roads.[24] Adult male camels have been reported to attain a body weight of 726 kg with the hump standing 2.1 m above ground and with long limbs adapted to wading through the deep Arabian sands which at the same time raise their center of gravity[14]. The hood of most small cars stands well below 1.2 m (Figure 1). When these cars are involved in collisions with camels they first hit the slender limbs, which propels the brute weight of the animal onto the roof and windshield, usually with severe consequences on the front seat occupants (Figure 2). This sudden ‘axial-load’ falling on the roof of the car, and directly down atop the front-seat passengers, could cause cervical compression injuries and permanent neurological impairments in the passengers.[25]

The occupants of the affected vehicles often undergo a pattern of avoidance reflex movement and 'protective flexion,' which in many accidents ends up being counterproductive as such reactions are likely to further increase the likelihood and severity of injuries.[24] Factors such as whether the driver and passengers were restrained by a seat belt may affect the pattern of injury sustained. Apart from neck flexion injuries, unrestrained occupants may sustain trauma dorsally on the cervical spine and on the occiput. Ducking horizontally on the seat is another reaction likely in unrestrained occupants that may increase the probability of fracturing the spine as a result of severe pressure from rotational, horizontal, extension and flexion pressure on the backbone.

When seat belt restraints are in place the possibility and degree of avoidance movement is greatly limited. Individuals are more likely to sustain compression fractures on the vertebrae, the head and the chest resulting from the direct impact of the camel's body on the upper section of the occupant's body.

The pattern of injuries may also be categorized in two other ways: injuries sustained from the primary crash or from secondary events. In the first instance the direct impact of the animal's massive weight against the vehicle, and all such events associated with this primary collision, constitute an important cause for injury in both humans and animals. The head-chest level of the occupants of the front seat of the car places them at such a position where the crushing weight of the animal is received axially on the head, neck and chest.[24, 26-27] This occurrence is a common mechanism of cervical and head injuries in camel-vehicle collisions (CVCs).

The second instance involves the desperate attempt of the driver (and passengers) to avoid an imminent collision with the animal. The result of such avoidance includes crashing into nearby structures such as trees, buildings or even passers-by. It may also, and not unusually, involve trauma sustained as a result of reflexive movements to evade the body of the camel. There have been reported cases involving the driver and passengers (usually without seat restraints) flexing and extending the head and neck protectively or laterally extending the spine and in the process fracturing the spine. Other reported injuries are lacerations from broken glasses, multiple rib fractures, spinal disc compression fractures and dislocations leading in some cases to complete paraplegia.[27-28,24] Both mechanisms of injury, however, are not mutually exclusive as they are sometimes found to co-exist depending on each WVC case. In a certain case reported at the Riyadh Armed Forces Hospital, involving a 34-year old male, both direct impact with the camel and protective flexion involving the neck reportedly resulted in the “traction and complete occlusion of the left internal carotid artery”.[26] Admittedly this was an unusual cause of trauma to the carotid artery more commonly reported in intense activities such as rugby and jockey.[29-30]

While ascertaining the mechanism of injury is a crucial aspect both for taking preventive measures and in managing injuries, the suggested mechanisms are often based on testimonies obtained from victims of the collision and from other witnesses of the incident. X-ray images of the injuries are usually of poor diagnostic value since they mostly represent the final or recoiled position of the affected part and as such provide no information about events leading to this recoiled position.

According to a report by the National Committee on Transport Safety of Saudi Arabia, 16 human casualties and 215 injuries reportedly resulted from a total of 341 WVCs documented in 1997.[27] This translates to seven out of every ten WVCs resulting in human mortality and morbidity. The annual incidence of WVCs in Saudi Arabia in another report was placed at more than 600 with a fatality rate of one out of every four WVCs, a rate said to be six times as high as all other types of road traffic collisions.

CHARACTERISTICS OF CAMELS CONTRIBUTING TO WVC

There are certain attributes and behavioral tendencies of Arabian camels that may influence the pattern of occurrence of WVCs on the highway and rural roads. Camels often travel in groups of between four and six across highways and rural roads in search of water and food or during their mating season.[22] Naturalized to desert conditions, camels have been known to travel several desert kilometers at a stretch. The hump stores up to 36 kg of fat which when metabolized produces the camel's required energy and about 1 ml of water per kilogram of fat, partly explaining why camels can travel up to 161 kilometers without water.[14,21,31] In addition they are able to drink large quantities of water (up to 150 liters) at a time.[32] Also, the presence of highly osmotically-stable oval-shaped blood cells instead of the regular circular blood corpuscles found in other mammals ensures the fluidity and integrity of the vascular tissue even under severely dehydrated conditions.[33-34] Camel owners often prefer to settle and house their camels within the vicinity of the highway to facilitate transportability, which further increases the likelihood of these animals wandering onto the highways.[21] They were even shown in Australia to exhibit inclinations to race with cars.[35]

The economic cost of the damage associated with WVCs is a substantial one, with incurred losses comprising the cost of treatment and rehabilitation of sustained injuries and associated fatalities; the cost of vehicle damage; loss of utility value attached to killed and debilitated camels, and the loss of valuable wildlife.[35-36]

RECOMMENDATIONS FOR PREVENTING WVCS INVOLVING CAMELS

The alarming rate at which collisions of vehicles with large animals (camels, deer, moose, and elk) takes place in many parts of the world has made it necessary to employ certain precautionary measures aimed at mitigating the trend and reducing the associated cost both in socio-economic terms and in loss of precious wildlife.[37] Although WVCs with large animals differ in regional and socio-cultural contexts, mitigation procedures employed in certain regions are generally applicable in other parts of the globe where WVCs are a major concern. Using statistical modeling with information from landscape properties, wildlife distribution and traffic volume, road ecologists suggest that WVCs are not stochastic occurrences but rather exhibit certain defined patterns specific to individual animal species.[11, 38-41] This insight is useful in the design of WVC preventive strategies.[11, 38-41] Landscape-related predictors, such as the presence of open habitat in the vicinity of motor ways (habitat fragmentation) and the presence of structures that are non-habitable to wildlife such as agriculture and urban centers, were respectively found to increase and decrease WVCs.[37] Predictors relating to the motor way, such as decreased visibility (typical of poor road lighting), high traffic (in rural areas with high population density of domesticated camels, for example), and a flat terrain likely to encourage over-speeding by drivers, have been identified as factors increasing the likelihood of collisions.[37]

Various measures have been suggested for preventing WVCs, some of which understandably are more relevant in certain parts of the world than in others. In a recent review by Gunson, Mountrakis, and Quackenbush[37] focusing mainly on WVCs in North America and Europe, recommendations included the use of wildlife over- and under-passes in conjunction with erection of highway fencing, especially in areas vulnerable to high rates of WVC. Further recommended measures included the use of reflective warning signs and signage that take the seasonal behaviors of the concerned animals into consideration, as well as vegetation management along highways, reduction of the speed limits with road constructs such as speed bumps where collisions are likely, and awareness programs to sensitize the public to the dangers of WVC.[37, 22, 40-43] In Saudi Arabia and in Northern parts of Africa the domesticity of camels adds another dimension to the observed pattern of WVCs. Understanding these additional implications potentially provides a platform for designing measures to control the behavior of the animals via education and legislation to ensure that camel owners take responsibility for preventing their animals from roaming unsupervised. In addition, the fitting of reflectors on camels similar to those used by cyclists in Europe will ensure the camels are sighted early allowing the driver time to avoid a collision.

Improvement of visibility on the highway and rural roads is highly recommended since it has been reported that more than 90% of collisions take place between dusk and dawn when the camels are difficult to detect until it is too late.[35] While the use of reflective warning signs is also recommended it is important to note that frequent users of the road soon get so used to them as to stop reducing their speed in response to the warning signs.[43] The effectiveness of warning signs is likely to be improved when combined with speed bumps installed in vulnerable areas of the road. Fencing has also been suggested, the effectiveness of which may be optimized when used in combination with over- and under-passes installed in strategic locations for the animals.[21] The construction of such structures is however highly capital intensive, and a great deal of maintenance is required to ensure their integrity, especially because camel owners have been observed to break fences in order to create passage for the camels.

Efforts should also be taken to ensure the breeding sites of camels are not located close to highways. On the part of the road users, attention to basic safety measures may greatly reduce the likelihood of injury in the event of a collision.[1] At the time of collision, for instance, 60% of motorists and 65% of cyclists were respectively not wearing seat belts or protective helmets.[1,13] Also, recently, a GPS-based Camel-Vehicle Accident Avoidance System (CVAAS) was proposed by Zahrani, Ragab, and Ul Haque, which is expected to locate animals near the road and notify drivers [21].

CONCLUSION

Public awareness through the use of multimedia and electronic platforms is recommend for educating and sensitizing the public to the danger of unsafe road practices and the poor supervision of camels. It is strongly recommended that drivers receive an education on the behavioral patterns of camels along the roadside, which can be integrated into the mandatory procedure for qualifying for a driving license. Punitive measures should be put in place against owners of unsupervised camels, and camel owners should be made aware of these. Lastly, a low speed limit should be established especially on rural roads and in areas with high camel population. Drivers' compliance can be obtained through the use of speed bumps and roadside warning signs. Traffic laws should also be enforced, and penalties for violation awarded to drivers disregarding established speed limits.

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Figure 1. Size comparison of camel and dear to an average human and passenger car.

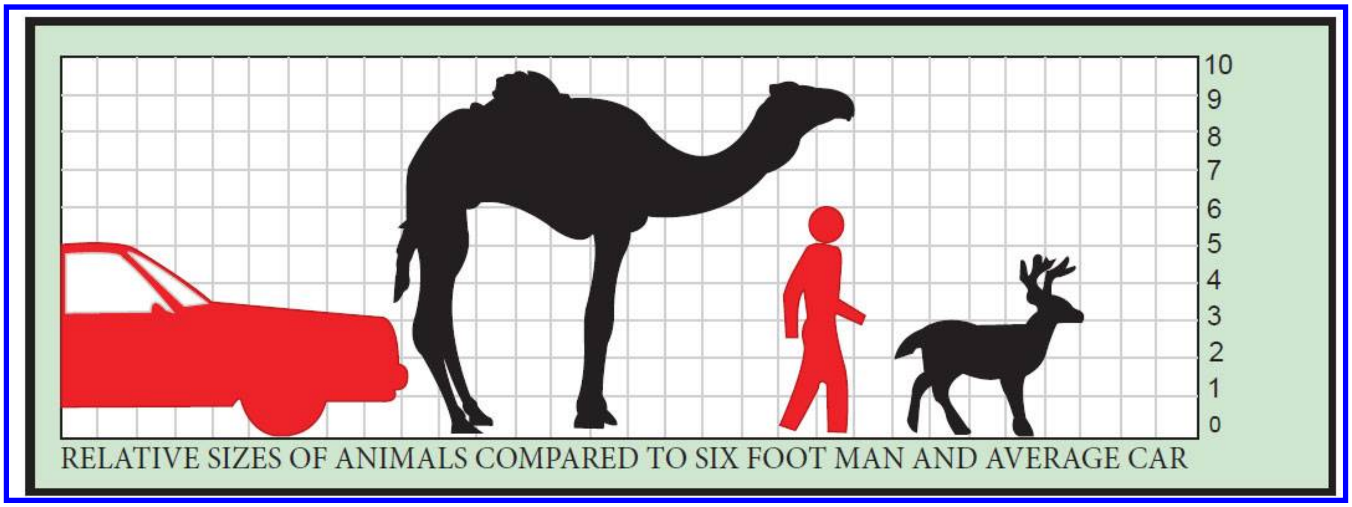

Figure 2. How collision with a camel results in the animal falling on and through the poorly reinforced frontal section of the car's upper surface (roof and windshield) usually with severe consequences to the occupants of the front seat.