Ocular injuries in a victim of a motor vehicle collision with a moose

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In Canada, motor vehicle collisions with wildlife pose an ongoing concern. Canada's landscape is abundant with national and provincial parks, and many of the highways and roads are surrounded by open wilderness. These areas are frequented by unpredictable animal crossings. Moose–vehicle collisions cause a characteristic pattern of head and neck injuries; ocular injuries may be part of the spectrum. We describe a case of multiple ocular injuries associated with a moose–vehicle collision to highlight the potentially devastating consequences of such a collision and the need to undertake preventive measures.

Case report

A 50-year-old male heavy-machine operator, while driving in northwestern Ontario, was involved in a frontal collision with a moose. His truck hit the moose's legs, and the moose fell through the front windshield onto the man. The shattered windshield perforated the moose's abdomen, spraying contents everywhere. The patient incurred significant facial and ocular injuries and was referred to an ophthalmologist in Thunder Bay, Ont. Initial clinical examination revealed a visual acuity of counting fingers in either eye. The sclera was totally green, owing to the presence of moose bile in the subconjunctival space. The patient could not tolerate a complete examination because of intense pain, swelling and hypersensitivity, so he was taken promptly to the operating room for examination under anesthesia.

Examination of the right eye showed traumatic mydriasis, a large corneal epithelial defect, conjunctival chemosis and a lateral conjunctival laceration. Exploration of the laceration revealed a large amount of subconjunctival and sub-Tenon's foreign material, which was removed. The foreign material included green-grey exudates, glass and particles of partially digested leaves and twigs. External examination of the left eye showed lacerations of the middle third and inner third of both eyelids, which were repaired. There were also medial, inferior and temporal lacerations of the conjunctiva and a large amount of subconjunctival, sub-Tenon's and anterior orbital foreign matter, which was removed. The foreign material consisted of partially digested twigs and stomach contents from the moose. The cornea was intact, the anterior chamber was deep, and there was a good red reflex.

Postoperatively the right eye progressed well, but the left eye had significant unresolving lid edema, and there was concern about severe orbital infection despite antibiotic treatment. Thus, the patient was transferred to a tertiary care centre in Toronto for further assessment.

The initial examination in Toronto occurred 1 week after the accident. The visual acuity in the right eye was 20/60, but it was questionable whether there was light perception in the left eye. Apart from conjunctival chemosis, the results of examination of the right eye, including funduscopy, were unremarkable. In the left eye, there was significant reduction of motility in all directions and significant lid edema, with purulent discharge through 2 areas of the eyelids. There was left conjunctival chemosis and a poor view of the fundi. B-scan ultrasound examination showed a normal right eye but a posterior globe rupture near the optic nerve in the left eye.

Computed tomography confirmed the left globe rupture with a foreign body (likely glass from the shat-

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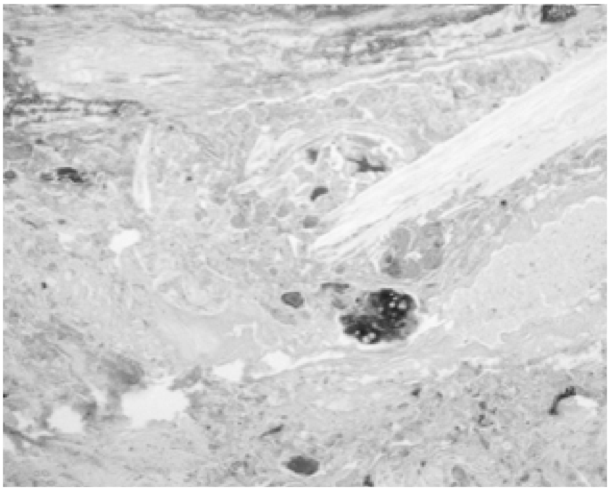

Fig. 1—Photomicrograph, showing necrotic material and plant material (hematoxylin–eosin; magnification ×100).

Fig. 2—The patient's left socket 7.5 months after the collision.

tered windshield) posterior to the inferior aspect of the globe. There was also suspected glass in the anterior aspect of the right orbit. Orbital bone windows revealed bilateral medial wall and floor blowout fractures and fracture of the left apex into the optic canal. No muscle entrapment was noted. Soft-tissue windows showed extensive orbital edema.

Because there was significant orbital inflammation and infection, the patient was observed closely for a few days, until the infection was better controlled. *Escherichia coli* was cultured from the left orbit discharge and antibiotic therapy continued. After a few days, when the infection had lessened but his vision remained at "bare light perception to no light perception," the patient was taken to the operating room. Intraoperative findings included a large hole in the left globe posteriorly, with avulsion of intraocular contents in the orbit. Because there was no possibility of salvaging anything from a globe repair, the left eye was enucleated. An implant was not inserted because of infection in the surrounding orbital tissue.

Histologic examination of the enucleated eye revealed inflammation in the cornea, sclera and choroid. Brown fragments found in the orbit intraoperatively were also studied histologically: they appeared to be necrotic material with plant material, likely partially digested stomach contents of the moose (Fig. 1).

After resolution of the orbital infection and edema, the patient was taken back to the operating room for reconstruction of his left orbit and insertion of a conformer in preparation for prosthesis fitting (Fig. 2), which was done over the next year, by an ocularist.

More than a year after the injury, the patient's condition was found to be entirely stable. His final visual acuity in the right eye was 20/60. There remained traumatic mydriasis and some cataract formation. Although there had been initial difficulties with prosthesis fitting owing to the extensive scarring of the left orbit, a comfortable and appropriate fit was eventually obtained, with reasonable cosmesis.

COMMENTS

According to the British Columbia Conservation Foundation,[1] in 2000 there were more than 30 000 collisions between animals and vehicles in Canada (with no distinction between domestic and wild animals). The Ministry of Transportation of Ontario[2] reported 11 126 collisions between wild animals and vehicles in 2001; 4 were fatal to humans, 490 involved personal injury and 10 632 involved personal damage. In northwestern Ontario, there are about 3500 motor vehicle collisions per year, one-third involving wildlife; of these, 400 are collisions with moose.[3] Moose collisions have the greatest potential for injury of humans and thus pose significant concern to society and, in particular, to our health care system.

The body of a moose causes a pattern of injury that is different from that of most motor vehicle collisions with animals. Adult male and female moose weigh an average of 450 and 350 kg respectively; their average height from hoof tip to scapula is 180 cm.[4] Owing to the high centre of gravity (undersurface of abdomen at or above the level of the vehicle hood) and long legs of these large animals, there is significant impact to the roof in 48% of moose–vehicle collisions and to windshield supports in 24%[5] (Figs. 3 and 4). This characteristic impact translates to injuries to the human head and neck.[6,7] The fractures observed in the patient in this case report are typical of those

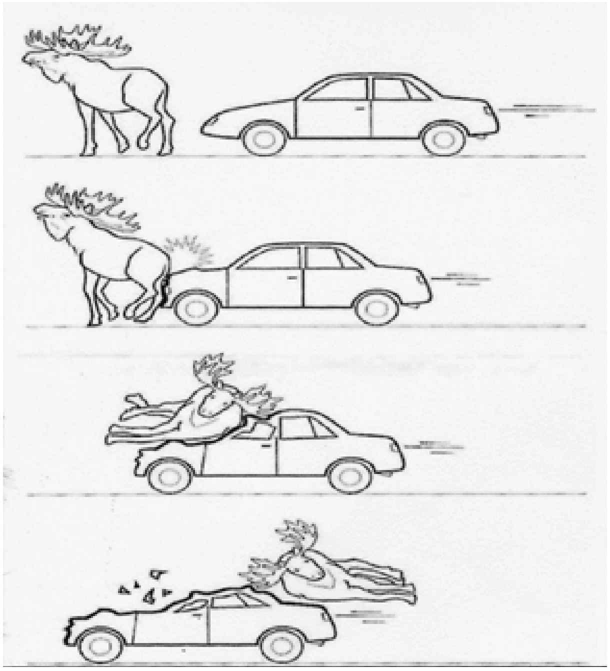

Fig. 3—Direct mechanism of injury with moose–vehicle collisions.

Fig. 4—Significant impact of moose with roof and windshield of vehicle.

of drivers and passengers in this type of direct collision.

In Ontario, there is a peak of moose–vehicle accidents from May to July. This has been hypothesized to be due to moose attraction to elementary sodium in roadside pools from highway salt accumulated over the winter.[8] Driving visibility is another factor, as most accidents occur within the first few hours after sunset.[9] Deeper snow in moose habitats may increase the use of roads as travel routes by moose, thus increasing the risk of collisions with vehicles.[10] These accidents are rare below certain latitudes (in Ontario, south of the latitude through the city of Orillia).

The rate of collisions with wild animals is increasing in every Canadian province because of new roads, more registered drivers and increasing human development in wilderness area.[11] A critical step toward reducing fatalities, injuries and property damage from such collisions on Ontario highways would be to record site- and species-specific data on such collisions for the Ministry of Transportation records. These data could be compared with the Ministry of Natural Resources data on habitat, migration and behaviour patterns of wild animals to investigate correlations between particular species and accidents.

If the geographic patterns of moose migration and behaviour were studied with respect to locations of roads and highways, motorists driving on roads with higher probabilities of moose encounters could be warned. There are "static" signs warning motorists now. However, "active" warning signs that sense wildlife movement and warn motorists in real time could be deployed. Warning reflectors or in-vehicle infrared wildlife detectors could be mandatory for vehicles traveling in high-risk corridors at particular times of the year. Overpasses could be created to allow moose to cross roads safely. These steps would protect not only motorists but also moose, which are vital to the health of the northern Ontario ecosystem.

Reports in the literature have discussed the management of maxillofacial, head and neck injuries but not ophthalmic injuries and management considerations in victims of moose–vehicle accidents. The timing and indications of orbital wall fractures should be managed according to the clinical presentation, as is recommended for treating orbital fractures in general.[12] Eyelid lacerations must be evaluated with careful consideration of eyelid margin and canalicular involvement.[13] There is a significant risk of infection with both gram-negative and gram-positive organisms from animal fur and feces, entrails, glass and other foreign bodies. As in our case, if there is rupture of intra-abdominal contents from the struck animal, gram-negative organisms such as *E. coli* may cause significant orbital inflammation. The timing and extent of orbital exploration may be influenced by the degree of infection. In the case of a ruptured globe, the possibility of enucleation must be addressed. Finally, after initial surgical management, the patient may require extensive orbital reconstruction and fitting of a prosthesis.

The ocular and periocular injuries associated with collisions between large wildlife and motor vehicles are usually complex and may require a multidisciplinary approach, with the involvement of ophthalmologists, ocularists, maxillofacial surgeons and plastic surgeons. The risk factors relating to season, geography, weather and time of day must be emphasized to drivers in an attempt to avoid these devastating injuries.

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