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Table of contents

1. An unusual pedestrian road trauma: From forensic pathology to forensic veterinary medicine.....	1
Bibliography.....	6

An unusual pedestrian road trauma: From forensic pathology to forensic veterinary medicine

Author: Aquila, Isabella; Di Nunzio, Ciro; Paciello, Orlando; Britti, Domenico; Pepe, Francesca; De Luca, Ester; Ricci, Pietrantonio

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Abstract: Traffic accidents have increased in the last decade, pedestrians being the most affected group. At autopsy, it is evident that the most common cause of pedestrian death is central nervous system injury, followed by skull base fractures, internal bleeding, lower limb haemorrhage, skull vault fractures, cervical spinal cord injury and airway compromise. The attribution of accident responsibility can be realised through reconstruction of road accident dynamics, investigation of the scene, survey of the vehicle involved and examination of the victim(s). A case study concerning a car accident where both humans and pets were involved is reported here. Investigation and reconstruction of the crime scene were conducted by a team consisting of forensic pathologists and forensic veterinarians. At the scene investigation, the pedestrian and his dog were recovered on the side of the road. An autopsy and a necropsy were conducted on the man and the dog, respectively. In addition, a complete inspection of the sports utility vehicle (SUV) implicated in the road accident was conducted. The results of the autopsy and necropsy were compared and the information was used to reconstruct the collision. This unusual case was solved through the collaboration between forensic pathology and veterinary forensic medicine, emphasising the importance of this kind of co-operation to solve a crime scene concerning both humans and animals.

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Full text: Collision with a pedestrian represents the most frequent type of road accident. It is often caused by a car and frequently it involves the elderly ^[1,2]. Collisions can be typical (or complete) or atypical (or incomplete). The typical form is characterised by a violent impact between a moving vehicle and a moving or stationary human body. It is characterised by successive phases where some elements can be noted: impact, knocking down, combination (or propulsion), surmounting (grinding) and dragging. During the impact phase, the subject is hit by a part of the vehicle, often the bumper; then the person is knocked down to the ground after being subjected to a sudden acceleration. The body, if projected along the travel direction of the vehicle, is drawn up by the latter and pushed forward. If the vehicle continues in its direction, it surmounts him/her with the wheels and possibly with other structures of the floor, and finally, it can hook and drag him/her even through the clothes. The atypical accident consists of a bump, sometimes particularly violent, from a vehicle having a low and sloping front, with a consequent projection of the body on the hood and then on the windshield with a subsequent possible impact on the roof and on the car trunk (so-called secondary impacts). This modality of accident is called loading and it happens when there is an impact below the centre of mass of the victim's body. In this case, the body falls down on the ground at the back or side part of the vehicle, and this explains the absence of the other phases of the typical accident. The injuries caused by the pedestrian accident are complex and can affect almost the entire body surface, even if the most frequent ones are injuries of the lower extremities and the head ^[3] (central nervous system injuries, skull base fractures, skull vault fractures, cervical spinal cord injuries, etc. ^[4]). The type and the distribution of external injuries may be affected by the shape of the vehicle, the possibility of an impact against protruding surfaces of the vehicle, the impact speed, the roughness of the ground on which the accident takes place and the presence of other obstacles faced by the body in the phase of the impact on the ground ^[5,6]. The initial contact of the bumper causes fractures and abrasions or ecchymosis of the lower limbs. These areas indicate the centre of the impact (so-called primary) between the subject and the vehicle. In case of loading, the injuries affect the upper parts of the body: head,

arms, shoulders, spine and chest. The traumatic internal picture is often characterised by widespread visceral injuries (visceral burst or pulping) and fractures and by parts of the body mangled or reduced to pieces. Animals may be responsible for an array of potentially lethal injuries, in particular traffic accidents^[7,8], even if often they are only the victims, as the presented case underlines. The introduced case concerns an atypical accident in which an old man and his dog were involved. For the evaluation of the lesions sustained by the animal, the collaboration with forensic veterinary medicine experts has been of great importance. This branch of forensic medicine is characterised by a great number of applications (e.g., assessment of animal welfare; determination of the cause, time and circumstances of death of an animal; verification of the origin and history of live or dead animals; etc.^[9]) and it can be very useful to perform clinical or post-mortem examinations when abuse of animals and violence to humans appear to be linked, as in this case.

In fact, the collaboration between the two forensic branches has allowed comparing human and animal lesions for solving crimes.

Case report

A case study concerning a car accident where both humans and pets were involved is reported here. During spring 2011, an old man and his dog were walking along a road when a sports utility vehicle (SUV) knocked them down. The driver stated that the man and his dog were walking in the middle of the road. The investigation and the reconstruction of the crime scene were conducted by a team composed of forensic pathologists and forensic veterinarians. At the scene investigation, the pedestrian and his dog were recovered on the side of the road. It was determined that an autopsy should be conducted on the man and a necropsy on the dog. In addition, a complete inspection was conducted on the implicated SUV. The results of the autopsy, the necropsy and the histological analyses were compared. This information was used to reconstruct the collision.

Materials and methods

An inspection was conducted in which some measurements were performed for the reconstruction of the accident dynamics. These measurements have given an account of the positions of the elderly man and his dog, comparing them to the positions of the car and the objects belonging to the victim. A careful inspection of the vehicle involved was also carried out. All the significant technical elements were reported and photographed. An external inspection and the autopsy of the man, the victim of the accident, as well as a necropsy of his dog were carried out, in addition to a histological research of the organs taken from both. All the collected data were compared analytically.

Results

Scene investigation

The body of the man was found in the prone position to a side of the road (^{Fig. 6}); his shoes were found away from the body - the right one was at a distance of 185cm from the SUV's front bumper and the left one was at a distance of 180cm from the dog's corpse. The body of the dog was at a distance of 200cm from the body of the man. The human body showed various contused and lacerated wounds at the level of the head (left parietal region) and face, with the presence of soil near the lips and on the entire face. The posterior right region of the singlet presented a large dark grey spot under which there were bruises and abrasions. The inspection of the vehicle revealed the presence of a red cord (similar to the fabric of the man's shoes) at the lower portion of the right bumper (^{Figs. 1 and 2}). The right portion of the bonnet's bodywork was broken and presented hair fragments; there were black dog hair fragments at the level of the lower lateral portion of the front bumper, at the right side.

Autopsy and necropsy findings

The autopsy of the man revealed: subarachnoid haemorrhage in correspondence of the left (direct hit) and right parietal regions (rebound lesion). A chest examination showed various rib fractures in the anterior right side and the presence of haemothorax; laceration of the descending aorta and fracture of T6 and T7 vertebrae. At the level of the abdomen, haemoperitoneum and liver lacerations were found. Finally, left tibia fracture was also revealed. The necropsy of the dog (^{Fig. 3}) showed a stab wound of the left back limb (^{Fig. 4}), the presence of

thoracic and abdominal haematomas, communication of thoracic and abdominal cavities, haemothorax (Fig. 5), haemoperitoneum, fractures of the left femur and of the left portion of the atlas and severe intraparenchymal bleeding at the level of the spleen and liver.

Histological findings

From a microscopic point of view, the man's heart presented some interstitial oedema with a reduction of the left coronary artery diameter (20%); then, histological examination revealed aortic atherosclerosis, endoalveolar haemorrhage and pulmonary emphysema, small oesophageal adventitial haemorrhages and adrenal haemorrhages in pericapsular fat tissue; the liver presented capsule and parenchyma laceration with haemorrhages of lesion edges; the kidneys were characterised by glomerulosclerosis and the brain showed some areas of subarachnoid haemorrhage with a slight cerebral oedema. Microscopic findings in the dog revealed widespread pulmonary haemorrhages; the spinal cord was characterised by small haemorrhages of the meninges; the kidneys showed the presence of interstitial nephritis; and at the level of the liver, some small necrotic hotbeds were observed.

Dynamic reconstruction

The comparison of the collected data has allowed carrying out a reconstruction of the accident dynamics:

impact of the right front-lateral bumper against the left back limb of the dog that caused a fracture of the left femur (Fig. 4);

subsequent loading of the animal inside the right wheel arches of the vehicle with hyperextension of the spine and subsequent fracture of the cervical vertebrae;

vaulting of the animal body that falls again behind the vehicle with subsequent injury to internal organs;

subsequent impact of the right front-lateral bumper against the rear side surface and left limb of the man's body (primary centre of impact);

contemporary impact of the left foot against the lower part of the right front-lateral bumper with consequent tearing of the left shoe and impact of the left leg that caused the compound fracture of the homolateral tibia; following loading of the victim on the front bumper and a consequent impact of his back on the right front-lateral hood as proved by the external traumatic case injury, the spine hyperextension and the vertebral fracture of T6-T7;

the pedestrian vaulting on the right bumper and simultaneous impact of the left parietal area of the head against the external surface of the right wheel arches of the vehicle and

the pedestrian falling again in the prone position behind the vehicle after an impact on the roadside that has caused an external traumatic injury to the right side of his body and to internal organs (rib fractures?haemothorax, liver laceration?haemoperitoneum).

Discussion

Pedestrian collisions are very frequent, but very often, it is difficult to determine the dynamics of the car crash. From a review of the literature, no case was found in which autopsies of the dog and man, both victims of the same accident, were compared.

The forensic pathologist has a central role in determining the reconstruction of the accident. The correct results are obtained only by performing a thorough inspection of the vehicle, persons or animals involved. Therefore, the forensic pathologist, in addition to determining the cause of death, must recognise the responsibility of the driver and the person knocked down. In this case, it has been important to compare the circumstantial data with the data relating to the injuries of the man and his dog. In particular, the execution of the autopsy on the dog has been critical to rule out any hypothesis of liability of the pedestrian or his dog in the genesis of the collision. Both the man and his dog showed lower limb fractures with features indicating a collision on the dorsal side of the body. Furthermore, the man and his dog showed cervical spinal cord injuries because of the traumatic neck bend. The comparison of the human and the animal fractures and the autopsy results excluded the presence of the man and his dog in the middle of the road. In fact, the biomechanics of injuries were suggestive of a collision

that struck the pedestrian and his dog from behind causing the propulsion along the roadside. This finding was supported by the presence of dog hairs and fibres of clothing belonging to the man on the right front bumper of the car. Data comparison allowed us to define that the man and his dog were walking on the side of the road and not in the centre, as the driver of the SUV claimed to exonerate himself from his responsibility.

The innovation of this work results from:

the execution of the necropsy on a dog in a forensic case;

the use of the collected data related to the animal to reconstruct the accident and

the data's forensic relevance in court to judge the statements of the driver and his responsibility.

This case highlights the importance of co-operation among the various branches of forensic sciences and the great usefulness of these kinds of collaborations in solving crimes ^[9,10].

The study highlights some points relating to what forensic pathology could lend to veterinary medicine.

The development of forensic science has allowed us to create a network of collaborations between seemingly different disciplines. In light of this, we can state that forensic pathology, when applied not only to humans but also to animals, could lead to significant progress in the forensic field. The presented case has shown it. We know, for a fact, that the branch of forensics is not currently developed and used daily in veterinary medicine. It would be appropriate that, even in the veterinary field, there was a development of veterinary forensic pathology. To this end, in such cases, it would be advisable to study the characteristics of the injuries through the more frequent use of the animal's autopsy survey. It would also be useful to train, even in the veterinary field, a specific professional who knows:

how to do the investigation and autopsy of animals and

how to interpret the results of the autopsy as in the forensic pathology of humans.

It is hoped, therefore, that a discipline of forensic pathology could develop in the veterinary field also that employs scientific and certified methods using appropriate case studies.

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Liver -- pathology, Male, Spleen -- injuries, Spleen -- pathology, Subarachnoid Hemorrhage -- pathology, Wounds, Stab -- pathology, Wounds, Stab -- veterinary, Accidents, Traffic (major), Multiple Trauma -- pathology (major), Multiple Trauma -- veterinary (major)

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