



CASE REPORT

AN UNUSUAL FINDING OF A GUNSHOT WOUND CAUSED BY A DIABOLO PELLET IN THE LIVER OF A CAT: A CASE REPORT

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Ethical considerations: When reporting experiments on animals Observation of the ARRIVE guidelines 2.0: Updated guidelines for reporting animal research, published on July 14, 2020 (DOI: 10.1371/journal.pbio.3000410), is applied. The authors ensure that all procedures were performed in compliance with the guidelines for animal care of their institutions or with national/international guidelines.

ABSTRACT

Here we report the accidental discovery of a gunshot wound involving a diablo pellet in the liver of a cat. Toxicology results investigating the possibility of poisoning by anticoagulant rodenticide-type agents (brodifacoum, bromadiolone, difenacoum, diphethialone, flocoumafen, and warfarin) and for cholinesterase inhibitor pesticides (carbofuran) were negative. Internal examination discovered minor amounts of free blood in the chest cavity and uncoagulated blood in the heart cavities. The cardiac musculature of the ventricles is hypertrophied, and cavities of the ventricles are narrowed. The lungs exhibit an edema, and there are extensive confluent diffuse hemorrhages. The kidneys are light brown in color, soft in consistency, with dotted or diffuse hemorrhages in the cortex and marrow. There is dark red fluid in the bladder. There is a slightly protruding structure in the center of the right lateral lobe of the liver in view of the diaphragmatic surface, in which the diablo pellet, with a wound, has been encased. Autopsy documents reveal renal failure. In relation to the autopsy findings, attention is paid to the impact of the release of lead from the diablo pellet into the body, impairing filtration, leading to renal failure and death. In the puzzle of the cause of death based on autopsy and toxicological findings, the work is a good example of the importance of considering several factors in renal failure even without further investigation.

Key words: entrapped diablo pellet; forensic medicine; gunshot wounds; renal impairment; veterinary pathology

INTRODUCTION

Injuries caused by firearms are usually life-threatening and often fatal. In this respect, air guns are generally considered less dangerous compared to, for example, professional hunters' weapons (rifles, shotguns). However, one cannot ignore the fact that airguns, as designed, have the potential ability to harm vital organs. Injuries, as well as deaths, of dogs and cats because of gunshot wounds have been reported in the literature [1, 2]. For example, in one study in a set of 171 animals that had been shot, a species ranking was compiled based on radiological and forensic examination, with dogs having the highest casualty rate (78.36 %), followed by cats (15.20 %), then rabbits (2.34 %), roe deer (1.17 %), and finally birds (2.92 %) [3]. Other studies also consider other forms of traumatic deaths. One reports that deaths of dogs and cats due to gunshot wounds were recorded at a lower rate than poisonings, but at a higher rate than deaths caused by blunt or sharp objects and occurred more frequently than deaths due to neglect [4]. In a study on traumatic deaths in cats, collisions with automobiles dominated, followed by attacks by other animals, followed by gunshot wounds [5]. In terms of therapeutic approaches, successfully resolved cases [6, 7, 8] as well as cases that were terminated by euthanasia [9, 10] have been documented in the literature. In doing so, it has been documented that up to 80 % of all gunshot wounds in cats were carried out with air guns [11]. Here, we report a case of an older airgun gunshot wound with an accidental finding of a diabolo pellet lodged in the liver. As such a case has not yet been described in the literature reviewed by us, we report it as unusual in relation to the primary cause of death in the form of renal failure. This work is a good example for veterinary forensic doctors and veterinary pathologists, where the causal relationships and causes of death of domestic cats are discussed based on the accidental finding of an encased diabolo pellet and renal failure.

CASE PRESENTATION

Case description

This is a domestic cat (♂, 9 years old) that was kept in home care with occasional outdoor activity. Cat was found lying unresponsive, breathing deeply and heavily. Despite

receiving priority admission at the veterinary clinic, the doctor's repeated attempts to revive the cat were unsuccessful. As the owner claimed, she had seen the neighbor shooting an air gun from his backyard earlier and, moreover, throwing unknown chemicals around. The case was investigated as a suspected criminal offense of cruelty to an animal, the intentional and unjustified killing of an animal by an unknown perpetrator, in an unknown manner. An autopsy has been ordered with toxicology screening for evidence of possible poisoning. Toxicological examination was carried out on a liver sample using the accredited high-performance liquid chromatography (HPLC) method.

Necropsy findings

The body of a 5.5 kg male domestic cat was received in a red plastic bag, covered in soil and with green clover leaves present (Fig. 1A). Otherwise, the coat is predominantly white with alternating patches of light brown and grey to completely black coloration at the tail. A cannula is inserted on the left forearm. External inspection of the body is without definite pathology. No signs of exogenous trauma after skin removal (Fig. 1B-1C). After opening the abdominal cavity, increased visceral fat is seen (Fig. 2A). After opening the thoracic cavity, a small amount of free, uncoagulated blood was present. Increased functional fat of the heart and uncoagulated blood in the pericardium and in the heart. Hypertrophied cardiac ventricular musculature with narrowing of the ventricular space. Mucosa of the trachea is smeared with blood. Mild pulmonary edema with extensive superficial confluent hemorrhages on the lung surface and in the lung parenchyma. The kidneys are light brown in color, soft in consistency, with dotted or diffuse hemorrhages in the cortex and marrow (Fig. 2B). A dark red fluid is present in the bladder (Fig. 2C). The spleen is without pathological characteristics (Fig. 2B). The liver is macroscopically dark brown in color, but a slightly protruding structure of pale color is present in the imaginary center of the right lateral lobe in view of the diaphragmatic surface, in which a diabolo pellet from an air gun is embedded (Fig. 3A). The area surrounding the embedded diabolo pellet is free of hemorrhage, with no other changes with granulomatous tissue, which is in contact with liver tissue, but the base is in contact with the liver parenchyma (Fig. 3B, 3C). The entire intestinal tract is more or less anemic. The stomach is empty, and there is



Fig. 1. View of the cat's body from the left (A), and after skinning in both individual and close-up positions (B-C) with no clear visibility of exogenous trauma

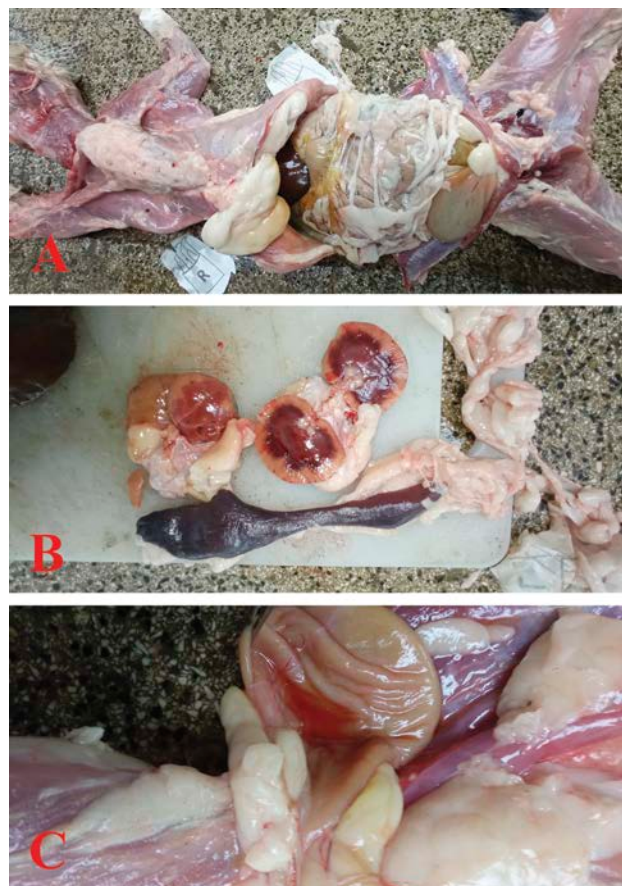


Fig. 2. View of individual internal organs with pale colored visceral fat (A). Kidneys tending to merge into a homogeneous dark red hue (B) with dark fluid in the bladder (C)

some slimy light brown coating on its mucosa. The intestines contain more pastosus than liquid contents of a light brown color, while the section near the rectum has firmer contents of a dark green color.

Toxicology results

The results of accredited screening tests for evidence of poisoning by anticoagulant rodenticides (brodifacoum, bromadiolone, difenacoum, difethialone, flocoumafen, warfarin) and for evidence of a cholinesterase inhibitor

pesticide (carbofuran) are shown in Table 1. Within the range of the set of seven chemically relevant substances monitored, the presence of positivity was not documented in any case.

DISCUSSION

In our necropsy practice, we routinely encounter animal deaths due to gunshot wounds, and it is not always

Table 1. The results of toxicological examinations

Indicator	Measured values (mg/kg)	Limits of positivity determination (mg/kg)
Brodifacoum	<0.005	0.005
Bromadiolone	<0.005	0.005
Carbofuran	<0.005	0.005
Difenacoum	<0.005	0.005
Difethialone	<0.005	0.005
Flocoumafen	<0.005	0.005
Warfarin	<0.005	0.005

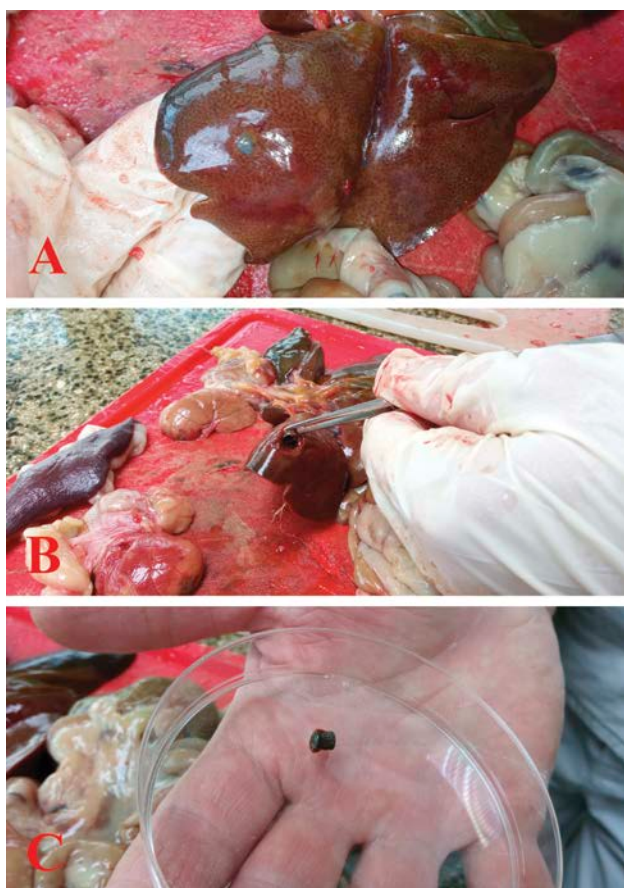


Fig. 3. View of the liver with parenchyma-fixed diabolito pellet (A) in contact with the liver parenchyma from the inside (B) and the diabolito pellet itself after dissection (C)

possible to trace the projectile. However, it is frequently possible to identify a gunshot trajectory with an entrance, a canal, and, possibly, an exit through which the projectile leaves the body and is unaccounted for. In our documented case, it was an older gunshot wound. Here, in our opinion, several alternatives can be considered in relation to the entry of the projectile, the gunshot canal, and the entrapment of the projectile in the liver. In the first case, the diabolito pellet passed cranially behind the ribs through the haired skin, the subcutaneous tissue, the space between the subcutaneous tissue and the peritoneum, then the peritoneum itself, then the space between the peritoneum and the liver, then became lodged between the diaphragm and the liver, being resorbed by the liver parenchyma over time. In fact, it is more likely that, along this pathway, it became trapped in the fatty tissue beneath the peritoneum, and in the process of gradual reparation of the wound, it was passively displaced into the space between the diaphragm and the liver, and only subsequently was it reabsorbed over time by the liver parenchyma itself. The second alternative is

based on the assumption of a shot with the above trajectory, but with the intervention of the liver parenchyma, where it became stuck, while its localization on the diaphragmatic surface can be explained by the temporal passage through the liver parenchyma even with the complete regeneration of the liver. A third alternative is a penetrating shot elsewhere in the body, with the diabolito pellet entering the bloodstream and subsequently becoming trapped in the liver. We favor the first possibility because the others, although feasible, are less likely. Often, and especially in cases of human firearm injuries, the possible movements of the projectile are discussed. The blood vessels in the liver are comparatively thin, and it is less likely that by arterial or venous circulation the entire diabolito pellet would reach the end of the lobe. This is documented in the case of the shot cat also with transport of the diabolito pellet through the arterial circulation, which ended up as embolization of the abdominal aorta [12]. In our case, the superficial part of the liver covering the diabolito pellet was surrounded in granulomatous tissue with organization, but the inner and surrounding part of the wound may not have closed, while there may have been preserved contact with the liver parenchyma. Although we have closed the case as being an instance of renal failure, it is hypothetically possible that over the years lead may have been released from the diabolito pellet into the host's system. In practice, acute lead poisoning is particularly manifested by gastrointestinal distress, whereas chronic poisoning is presented with a broader symptomatology with damage to the reproductive organs, kidneys, and nervous system [13]. In doing so, a relationship between kidney damage and lead has been demonstrated [14]. This could be suggested by the autopsy findings of the kidneys with loosening of the parenchyma and hemorrhages. These facts could also be attributed to progressive autolytic changes, which would then be present in other organs as well. These, however, appeared vital in their macroscopic appearance. Evidence of damage to the kidneys is also provided by the dark-colored fluid in the bladder, which corresponds to impaired filtration. Here, however, it is controversial whether lead toxicity is manifested at low levels or only with repeated exposure to high levels. It is less likely that a single diabolito pellet is the cause of poisoning, but on the other hand, the results of studies that have confirmed the relationship between fragments of residual projectile parts in the body of shot individuals with lead admixture and elevated lead

levels in their blood cannot be ignored [15]. As long as lead compounds remain in contact with stomach acid, near the joint, or synovial fluid, lead poisoning can be possible, and deaths due to lead poisoning have been reported in this way [16]. Although we have not been able to verify blood lead levels in the setting of basic necropsy equipment, we can at least theoretically concede that the stuck diabolo pellet may have contributed to the development of pathological changes that ultimately resulted in renal failure. A basic set of toxicological investigations looking for evidence for anticoagulant rodenticide poisoning and for the pesticide cholinesterase inhibitor were negative in this case. Other types of poisoning are less likely, although this was a domestic cat that had been kept in a household, went out into the garden, and was accustomed to meat and meat products. He may have taken these from other people or accidentally eaten them. Based on our experience with the types of poisoning from this area, this reduces the likelihood of poisoning by another active substance. Despite his age and being overweight with increased stores of depot tissue, cardiovascular failure is a less likely cause of death as well. Here, we rely on our autopsy findings of free blood in the thoracic cavity and free uncoagulated blood in the cardiac cavities. Such findings are more common in poisonings. In cases with direct evidence of the presence of metabolites of anticoagulant rodenticides alongside cholinesterase inhibitor pesticides, the findings are accompanied by dark-colored, bloody viscera. Further, with the presence of more or less uncoagulated blood in the abdominal cavity and the thoracic cavity, hematomas in the musculature, discharge of uncoagulated blood from body orifices, and uncoagulated blood in the heart. In our case, the gastrointestinal tract was pale colored, and there was renal damage with failure of filtration and blood passing into the urine. These facts are commonly reported in adult cats, and our case could also, ultimately, be concluded as chronic kidney disease resulting in renal failure [17, 18]. However, our case was a domestic cat, and in addition, we documented the aforementioned diffuse hemorrhages in the lungs in the autopsy findings, but they were not clearly present in other organs. Therefore, without the benefit of other examinations, we concluded the case as being an instance of renal failure, which could have had multiple causes, including the possibility of the role of lead compounds from the trapped diabolo pellet in the liver.

CONCLUSION

We discuss the causes of death based on the accidental diagnostic finding of a gunshot wound with an entrapped diabolo pellet in the liver of a cat. Autopsy documented that it was renal failure, which, combined with the above finding, opens up a discussion of the possible role of lead with progressive filtration impairment and renal failure that ultimately led to death. These facts provide a good example for veterinary forensic doctors and veterinary pathologists to consider combinations of causes of renal failure in the setting of basic necropsy equipment without further special investigations with suspected and subsequently unproven poisoning.

Conflict of Interest

The authors declare no conflict of interest.

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Generative AI Statement

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Authors' Contributions

Conceptualization: MaM and KK. Methodology: PB and PaM. Investigation: PB and PaM. Data curation and supervision: PB and PeM. Writing—original draft preparation: MaM. Writing—review and editing: KK and PeM.

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