

K. De Munnynck · W. Van de Voorde

Forensic approach of fatal dog attacks: a case report and literature review

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Abstract Over 1 million dog bites occur every year in the USA, however, fatal dog bites are rare and mostly affect children under 4 years of age and old people. Usually pet dogs are involved and only recently has public awareness of this health problem increased. As an example of a forensic approach we present the case of a 6-year-old girl who was killed by the three pet Rottweilers of her father. The present report includes the investigation of the death scene, the autopsy findings and the results of the examination of the dogs. Dog bite wounds in this case typically were limited to the head and neck regions and classic features of these wounds have been described in various studies. We emphasise the particulars of canine dental features, discuss the resulting bite wounds and, reviewing the literature, try to come up with a strategy for prevention.

Keywords Fatality · Rottweiler · Dog bite · Asphyxia · Haemorrhage

Introduction

Dogs are "a man's best friend" and it is true that dogs, and before them wolves, have been domesticated for over 15,000 years [1]. Today we know more than 400 breeds that share people's homes and serve many purposes: as companion, guardian, helper, hunter, etc. Many qualities and an incredible adaptability have made them indispensable for a number of tasks but children and old people sometimes pay a high price for this close relationship. Animal bites are a major health problem in our modern world; for example approximately 1–2 million dog bites occur every year in the United States with a dog population of 25 million [2]. In Hong Kong 200 dog bites are recorded every

month and every year about 30,000 dog bites are recorded by insurance companies in Germany [3, 4].

A bite is defined as any break in the skin caused by an animal's teeth, regardless of the intention [5] and three patterns have been observed: non-fatal dog bite wounds that can be light, severe or life-threatening, dog bites that directly or indirectly (through infection and sepsis) lead to the victim's death and post-mortem lacerations of the victim's body [6].

Children in the 5–9 year age group are bitten most often, with 78% of the bites located on the extremities. In the group of children younger than 4 years, 63% of bites are to the face, head and neck, usually severely and often even fatally injuring these children [5, 7]. Of all dog bite deaths reported in a 5-year period, 31% of the victims were infants in the first 12 months of their lives, who were left unattended in a crib [5].

In general, fatalities due to dog bites are rare. From 1979 to 1998, only 238 deaths were reported in the United States [2, 8].

Pit Bull Terriers, German Shepherds and Rottweilers are the breeds most often involved in these fatal attacks, 70% of which are committed by a pet dog within the own-ers yard or its proximity [9].

We present the case of a young girl bitten to death by the pet dogs belonging to her father.

Case history

On a sunny winter day, a 6-year-old girl was attacked by the three male Rottweilers of her father while playing in the garden, apparently for no reason at all. Because the girl was familiar with the dogs no adult was present in the immediate vicinity. On arrival, helping hands could do little more than chase the dogs away and assess the damage as the child was already dead.

At the prosecutor's request a complete forensic examination was performed.

Investigation of the death scene

The body was lying face down in the bloodstained snow. In an area of 5×5 m semi-circular tracks showed how the dogs had dragged

K. De Munnynck · W. Van de Voorde (✉)
Centre of Forensic Medicine, University Hospital K.U. Leuven,
Minderbroedersstraat 12, 3000 Leuven, Belgium
e-mail: Wim.Vandevoorde@uz.kuleuven.ac.be,
Fax: +32-16-336554



Fig. 1 Claw marks (multiple linear lesions) and deep laceration on the back of the head and neck



Fig. 2 The typical "hole and tear" configuration. Stretch laceration above the eye

the body around and strands of her long hair were found all around. The rest of the garden showed no other signs of a fight.

The child was wearing warm winter clothes that seemed to be intact. Injuries were apparently limited to the head and neck region and the face was covered with blood. A deep laceration at the back of the neck revealed the cervical spine (Fig. 1). There was no rigor mortis, nor were there any livores apparent. Head and thorax were still warm despite the freezing temperature.

The expert's first findings indicated that the girl had died less than 3 h previously, probably of severe blood loss due to severe bite wounds to the head and neck.

Autopsy findings

The autopsy was carried out 16 h post-mortem. Examination of the undressed body showed a normally developed body of a 6-year-old girl with a weight of 22.9 kg and a body length of 127 cm. There were no livores apparent and the rigor mortis was moderately developed in all articulations. Injuries were limited to the head and neck regions that showed a deep laceration of 15×6 cm at the back of the head. The trapezoid muscle was involved in this lesion and part of the occipital bone lay bare. The back of the head was mostly bald revealing several linear excoriations and pulled-out hairs (Fig. 1). There was extensive abrasion of the face with bruised lips and petechial haemorrhages on the conjunctival mucosa of the lower eyelids. Above the left eyebrow was a stretch laceration of 4×5 cm and in the left parietal region there was a similar wound above the ear (Fig. 2). The nose also was severely lacerated. Under the chin a deep gaping wound of 7×2 cm exposed the perforated thyroid cartilage (Fig. 3). The rest of the body seemed intact and there were only some small bluish bruises. There was no evidence of some sort of defence actions.

The internal examination revealed no pathological findings except for a small amount of blood in the airways. Dissection of the neck showed deep laceration of the musculature with avulsion of the right lateral processes of the cervical vertebrae C1 and C4. The larynx was anteriorly perforated at three different sites: two perforations at the level of the vocal cords and one below each measuring 4×5 mm. The right jugular vein revealed a small transmural tear (Fig. 3). There were no signs of air embolism, the brain was swollen but otherwise intact. Histological and toxicological examinations did not reveal any extra relevant facts.



Fig. 3 Fatal wound with perforation of the jugular vein and larynx

Investigation of the dogs

The three dogs were put down and at autopsy no important infections or neoplasms were found (Prof. Dr. R. Ducatelle, Department of Pathology, Bacteriology and Diseases, Faculty of Veterinary Medicine, University of Ghent). The brains were found to be normal with no evidence of rabies infection, neither microscopically nor in neuroblast culture (Pasteur Institute, Brussels). Toxicological examination of urine samples was negative for the presence of stimulating substances (Prof. Dr. P. De Backer, Department of Pharmacology, Pharmacy and Toxicology, Faculty of Veterinary

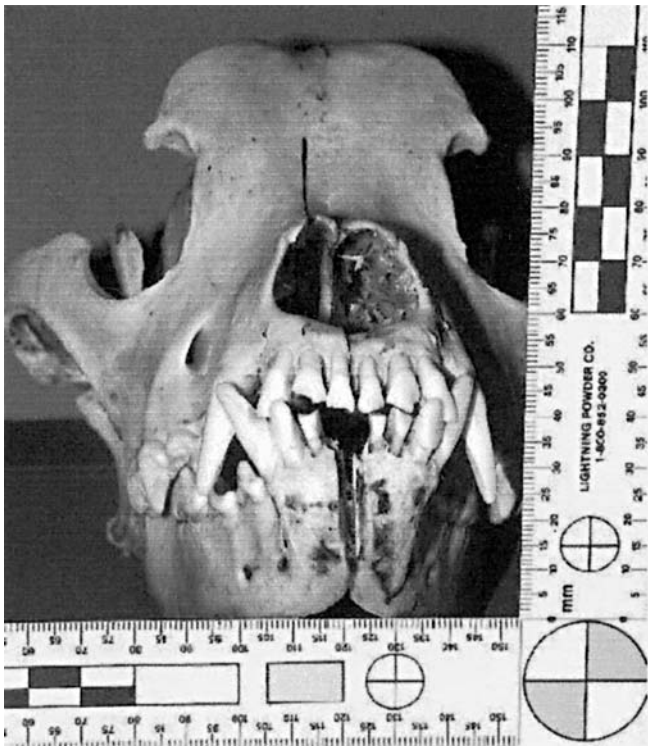


Fig.4 Skull of one of the Rottweiler dogs

Medicine, University of Ghent). No human tissue was found in the mouth or gastric contents.

The skulls with full dentition were prepared (Fig.4) but bite mark analysis was considered less useful in this eyewitness case. No attempts were made to link the individual dogs odontologically to their individual bites, because a witness saw at least two of the three dogs simultaneously attack the girl.

There was no apparent pathological or toxicological status that could explain the violent behaviour of the dogs (Prof. Dr. M. Verdonck, Faculty of Veterinary Medicine, University of Ghent, animal expert in this case).

The conclusion of the forensic investigation was accidental death caused by a bite wound to the neck, opening the jugular vein and perforating the larynx. Death was attributed to asphyxia and external bleeding. Most likely, the child had been surprised by the violent behaviour of the dogs and had sustained the fatal wounds at an early stage during the attack. All pathognomonic features of dog bite wounds i.e. puncture wounds next to stretch lacerations on a body showing several claw marks, were present on the body.

Discussion

Accurate estimation of the annual incidence of animal bite wounds is difficult because many bitten individuals fail to seek help. Epidemiological studies indicate that most dog bites are of minor severity, yet half of the reported bites leave permanent scars and one-third of these attacks cause disability [10].

Fatal dog bites are rare with an incidence of 7.2 deaths per 100 million population per year in the United States [11]. Victims are under the age of 12 in 85% of the cases and younger than 10 years old in 70%, with one-third of all deaths occurring among infants less than 1 year of age [2, 5]. So victims of fatal dog bites are mainly very young and very old people, i.e. those least able to protect themselves [4, 7].

Most dogs involved in biting or attacking are known to the victim and about one-third belong to the victims family [11]. Pet dogs account for 93% of bites to children under 4 years old and for 75% of bites to children 4–16 years old. In fact, the family dog was involved in nearly 70% of the fatal attacks [12]. Surprisingly, stray dogs are usually involved in attacks of a more innocent nature [7].

Biting incidents occur most frequently in or around the home of the victim. Although chaining or fencing in a dog may seem a certain way to prevent bites, many bites occur while the dog is restrained in some way. Attacks by pet dogs often lead to wounds in the head and neck region, while stray dogs commonly deliver bites to the hands and legs. The fact that people behave differently towards their own dogs than towards stray dogs may explain this difference. Likewise children are almost always bitten in the head and neck region because these body parts are at the level of the dogs teeth [7]. Victims of dog bites can be found completely undressed which may erroneously suggest a sexual assault rather than a dog bite setting [3, 6, 13]. On the other hand, rape of humans by dogs has also been reported and canine sperm can be detected both microscopically and with DNA analysis [14, 15].

In general male dogs, especially the non-neutered, bite more frequently [11]. Younger dogs also tend to bite more often with dogs aged 6–11 months having the highest bite rate [7]. The size of the dog, on the other hand, seems unimportant when it comes to biting.

Table 1 Biting rates of important “biting” breeds

Authors	Total number of bites	Number (%) of bites by different breeds				
		Pit Bull Terrier	German Shepherd	Rottweiler	Mongrel (mixed breed)	Other
Sacks and Sattin [2]	101	42 (41.5)	9 (8.9)	5 (4.9)	22 (21.7)	Husky 7 (6.9)
Reuhl et al. [4]	20	–	6 (30.0)	5 (25.0)	–	Husky 1 (5.0)
Sacks et al. [8]	238	66 (27.7)	17 (7.1)	39 (16.3)	64 (26.8)	Husky 15 (6.3)
Sacks et al. [11]	109	24 (22.2)	10 (9.2)	16 (14.8)	23 (21.1)	Husky 5 (4.6)
Jarret [12]	75	–	27 (36.0)	3 (4.0)	11 (14.6)	Collie 5 (6.6)
Gershman et al. [16]	178	–	34 (19.1)	–	–	Chow Chow 31 (17.4)
Shewell and Nancarrow [25]	146	15 (10.4)	9 (6.2)	–	10 (6.8)	–
Lauer et al. [32]	194	–	34 (17.5)	–	48 (24.7)	Poodle 20 (10.3)

Table 2 Forensic investigation of fatal dog attack

Investigation	Stages	Evidence
Scene investigation	1. Information	Circumstances, witnesses, age of victims, dog breed, etc.
	2. Observation	Traces, environmental conditions, position of the body, etc.
	3. Collection	Trace evidence, blood samples, etc.
	4. Documentation	Photographs, sketches, diagrams, etc.
Examination of the victim	1. Information	Age, relationship to dog, health status, psychological profile, etc.
	2. External examination (preferably at the scene)	Bite marks (tear and hole), defence wounds, post-mortem changes, injuries, health status, etc. Collection of trace evidence
	3. Internal examination	Collection of samples for toxicology and DNA analysis Cause/mechanism of death
	4. Toxicology	Alcohol, substance abuse, etc.
	5. DNA analysis	Identifications of dog hairs found on victim, etc.
Examination of the dog	1. Information	Age, owner, previous behaviour, health history, relationship to victim, etc.
	2. External examination	Collection of trace evidence (blood, cloth, soil, hairs, etc.) Health status, wounds, etc.
	3. Internal examination	Collection of oral contents, gastric contents, blood, brain tissue, urine, etc. Pathological conditions
	4. Toxicology	Toxic substances, stimulating substances, etc.
	5. Microbiology	Exclusion of rabies, infections, etc.

Various studies suggest that some breeds are particularly prone to biting (Table 1) and Pit Bull Terriers and Rottweilers are always high in the ranking, especially when the severity of the wounds is taken into account [7, 8]. The German Shepherd, the Husky and mixed breeds or mongrels are also often mentioned [12, 16]. We wish to emphasise that dogs acting as a pack are far more dangerous than the same animals individually and it is also important to note that when a dog has bitten once, it will most likely bite again [17, 18].

Dogs have some very specific dental and maxillofacial features (Fig. 4). They have 42 teeth, 20 in the upper jaw and 22 in the lower jaw. Usually the mandibular dental arch is narrower and shorter than the maxillary and the shape of the dental arches varies among the different breeds. There are natural gaps between the teeth that are attenuated or accentuated depending on the breed [6, 19]. The canine masseter-ptyergoid complex is short and strong and its insertion on the mandible provides a powerful mechanical advantage. Vertical forces exceeding 450 pounds per square inch, i.e. 31×10^4 N/m², have been measured during a dog attack, which is sufficient to penetrate sheet metal [20].

The above features attribute to the characteristics of dog bites. The maxillary teeth distal to the mandibular teeth allow the so-called scissor-bite with which the dog can lock onto his prey. The tremendous force the bite muscle complex can develop, allows the dog to twist and tear and cause great damage. The injuries caused involve a combination of biting, crushing and tearing that results in a characteristic pattern of punctures, lacerations and avulsions of skin and soft tissue. Forensic pathologists noted multiple torn wounds with adjacent puncture wounds, the so-called a-hole-and-a-tear combination [16]. The puncture wound, a round hole, is made by the canine tooth of either the upper or lower jaw on one side that

serves as an anchorage, while the other teeth cut into the flesh causing stretch lacerations in the process of biting, shaking and tearing. This should be considered pathognomonic for dog bites, especially when accompanied by tissue defects and claw marks, the latter being narrow, superficial linear abrasions arranged parallel to each other, four or five in number and usually found in the vicinity of the bite [3, 13]. This pattern allows differential diagnosis with bites of other animals which are not accompanied by pulling and shaking nor by the usage of the prominent canine and with stab wounds caused by sharp instruments [3, 21].

In conclusion, to identify a lesion as a dog bite wound it should have ragged and irregular wound edges, show multiple, parallel, linear scratches or drying scuff abrasions, include a puncture wound and sometimes an avulsion with irregular borders resembling a dental arch print [22].

The shape of dog bite wounds depends on the size and the breed of the dog and will differ whether or not the full dentition was used to produce them. Only in ideal circumstances will a complete impression of all frontal teeth be found and often only a prominent canine impression can be seen [6]. Bite mark analysis is a very delicate task. Well-qualified people have differing opinions regarding the interpretation and proper use of bite mark analysis. To overcome endless discussions about its scientific value as evidence in court, in 1984 the American board of Forensic Odontology formulated written-down guidelines for human bite mark analysis, which are equally applicable to other species, including dogs [23]. Careful use of these guidelines in an animal bite analysis will enhance the quality of the conclusions. The collection of evidence falls into three different categories: description of the bite mark, collection of evidence from the victim and collection of evidence from the suspect. Thorough analysis of all collected evidence can lead to useful conclusions [23].

Mostly fatal lesions are located in the head and neck region involving soft tissue laceration, larynx crushing as well as opening or compression of the extracranial vessels, causing death by means of asphyxia or haemorrhage [4, 17, 19, 20]. Septic shock and craniocerebral trauma have also been reported as possible causes of death [4]. Infections of dog bites are especially dangerous in those who are innately or therapeutically immune-depressed or have undergone splenectomy. One death by pulmonary embolism has been reported after calf cellulitis complicating a dog bite [24]. Apart from the head and neck region, the extremities may also be involved in dog bites because these are used in defence movements.

A forensic approach to a fatal dog attack should include a detailed assessment of the scene, the victim and the dog (Table 2). The examination of the dog may in fact involve more time and effort than the post-mortem study of the victim. The dog should be examined for trace evidence that can link it to the victim (e.g. blood, hair, clothing fibres) and that can help to reconstruct the event (e.g. soil, grass etc.). Infectious diseases should be excluded, especially rabies but other pathological conditions such as brain neoplasms, encephalitis, diabetes mellitus, etc. also have to be considered because they can alter canine behaviour. A urine sample must be examined for the presence of stimulating substances. It is also worthwhile examining the oral and gastric contents of the dog, the latter during autopsy, for blood, tissue or clothing. For obvious reasons this has to happen as soon as possible after the attack. If the dog cannot be put down, it can be anaesthetised in order to allow examination of the oral cavity, dentition and if bite mark analysis is necessary to make a dental cast [9, 25]. Detailed photography and body diagrams of the dogs as well as photographs of collars, scars and evidence of prior veterinary therapy are useful when the identity and owner are unknown. If the identity is known, past behavioural patterns have to be established because nowadays more and more dogs are trained to attack and protect the property of the owner.

Recently DNA analysis both of blood found on the dogs coat or in their mouths and of hairs found at the scene of the crime or on the victim's body has gained importance in forensic investigations. Especially the study of hairs by mitochondrial DNA sequencing or analysis of the presence of canine-specific short tandem repeat systems by fluorescently labelled multiplex PCR have proved useful in reliably linking dogs to the scene of a crime or attack [26, 27, 28]. In another reported case the dog was vindicated because the blood on his coat did not belong to the victim and other forensic evidence also failed to connect the dog to the victim [29]. The study of mitochondrial DNA and more specifically the nucleotide sequence of the cytochrome b gene, can also be helpful to analyse stains of non-human origin: this cytochrome b gene contains a 300 bp region that can be used to identify the species involved [30].

Of course a full investigation of the victim includes collection of trace evidence, autopsy and toxicological examination whenever appropriate. Information about past

behaviour of the victim towards dogs in general and this dog in particular may also be valuable when one tries to find an explanation for these fatalities.

A complete forensic approach i.e. examination of victim, dog and scene, may enhance the possibility of successfully reconstructing the event. Furthermore, a detailed and objective evaluation will contribute to increase the public awareness to this health problem and also accessibility for possible preventive measures. Justice will also be better served in any criminal or civil action that may evolve.

If dog bites are to be prevented, it is necessary to understand not only the circumstances but also the behaviour of both dog and victim [5]. Why is it, for example, that a pet dog will seldom attack a child that is lying still on the floor but will jump to a child that falls or trips over something?

All dogs are social animals and possess an inherent pack instinct [9, 17] which is central to their survival in the wild. A social hierarchy within the pack allows the members to assume their places and to function from those positions [31]. Communication among pack members is demonstrated and understood through specific body language. The pack of a domesticated dog however, is a "family pack" including humans and joining human and canine species in one pack may invite problems. Unaware of species differences, individual pack members, both dogs and humans, may misinterpret many of the other one's signals, causing unpleasant and sometimes dangerous consequences. The best proof of this is the fact that the majority of reported dog attacks seems to have happened "unprovoked", meaning that both parents and children failed to see what their behaviour meant to their canine companion [5, 11, 12, 31, 32]. Furthermore, too many human characteristics are assigned to dogs, the so-called anthropomorphism. In general dogs are labelled aggressive on the basis of past behaviour or breed. Some of the aggressive reactions of a pet indeed relate to genetically controlled breed characteristics but they can equally be derived from environmental circumstances and learning. Different types of aggression leading to attacks in different circumstances can be distinguished: dominance aggression when the dog challenges a member of the pack, e.g. a new baby, protective aggression when the victim is regarded as a threat to the family, possessive aggression towards a victim that invades the dog's territory or attempts to move an item "possessed" by the dog, e.g. food or toys [9, 25]. Also pain and fear, especially in dogs that have been maltreated, can provoke aggressive behaviour but, from time to time, the aggressive behaviour remains unexplained. This last category includes genetic and neurological impairments as well as unknown environmental precipitators, and the only "treatment" is to put the animal down.

Regardless of the antecedents or consequences of aggressive behaviour, the response itself is often stereotyped. The dog's body language i.e. his facial expressions, tail movements and postures often provide information that many potential victims do not recognise [33]. Of course not every victim can be blamed for failing to understand a dog's psychology. This is especially true when

children are being attacked. It is important to choose a breed that suits the family situation and to train it well. People, and especially children should be taught how to respond to dogs and how to react when aggressive signals are being perceived. A child should, however, never be left alone with a dog [2, 5].

From this point of view, many risk factors were present in our case. A little girl was left alone with a pack of three large adult male, non-neutered Rottweilers on their territory. One of the dogs had a previous history of biting. Witnesses pointed to an air balloon that passed by as a possible environmental trigger of the violence. Recently, a similar case of a 5-year-old child killed by a Rottweiler was briefly mentioned by Prahlow et al. [21].

Conclusions

Fatal dog bites are fortunately rare in our society but, sadly affect mostly small children and are very often caused by pet dogs.

Diagnosis is mostly not a difficult problem considering the rather pathognomonic wound pattern of "a-hole-and-a-tear" together with skin abrasions and claw marks. The head and neck region is very often severely affected and the cause of death is usually haemorrhage and/or asphyxia.

A complete forensic investigation (Table 2) can help to reconstruct the event, to identify the attacker, to exclude criminal intention, to identify a pathological condition or bring out another explanation. It should involve the victim, the dog and the attack scene. Bite mark analysis is still controversial but, performed according to the guidelines of the American Board of Forensic Odontology, may be helpful to identify the dog involved and DNA analysis can also be of value in dog identification.

A better understanding of animal behaviour is necessary in a preventive strategy. As a rule dogs and children should never be left unattended, our case report being a sad testimony of the consequences.

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