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Comparison of Human and Dog Bitemarks

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Abstract: The origin of traumatic injuries from bite is often an additional problem for the specialist who must determine whether this dental imprint is caused by human, animal or some other mechanical impact and simply resembles dental imprint. Further identification problems can be raised while trying to attribute of a specific morphological feature of postmortem damage to a distinct species of animal.

Key words: Dog bites, human bitemarks, postmortem injury, rodents bites, animal, Greece

INTRODUCTION

Animals like dogs are one of the closest species to human as they have been kept as pets and companions as well as for hunting and guard purposes (Kneafsey and Condon, 1995). However recently, the subject of dog bites has increasingly come to the forefront of the public attention with many case reports been published the last decades (Kneafsey and Condon, 1995; Santoro *et al*., 2010; Rothschild and Schneider, 1997; Verzeletti *et al*., 2010). Because of this, it has become necessary to implement advanced methods of comparing dog bites, human bites and bite of other animals, such as rodents. Animals also often prey on human postmortem, disturbing the corpse and its surroundings and creating even more problems for those investigating the scene (Tsokos *et al*., 1999a; Verzeletti *et al*., 2010; Haglund, 1992). The animals who may be are excited to frenzy by the smell and taste of blood often bite the corpse and as a result its more difficult to interpret the exact cause of death (Santoro *et al*., 2010). This leads the forensic investigators to disagreements about bite marks and the animals they belong to.

COMPARISON OF HUMAN AND DOG BITEMARKS

Human: Without a doubt the dog is the most common culprit of animal bites on humans (Silver and Souviron, 2009). In order to avoid cases of misdiagnosis, the researchers analyze certain characteristics of dog and human bitemarks. A paradigmatic human bite is an elliptical or circular injury. It may be one single mark or two U-shaped arches that are separated at their bases by an open space. The diameter of the injury typically ranges from 25-40 mm (Sweet and Pretty, 2001). The injuries caused by teeth can range from bruises to scrapes and cuts or lacerations. There may be as many as 16 individual tooth marks (8 in each arch), although between 6 and 12 is more often the case. Incisor teeth record as linear or rectangular markings and cuspids as circles or triangles (Bernstein, 1997). Also in well imprinted bites, the upper arch can often be distinguished from the lower from the fact that it is larger. The researchers should also point out that the upper arch most of times is less defined than the lower which holds the skin more securely (Bernstein, 1997). The differentiation between the incisors of the upper and lower arch will play an important role in the procedure of identification because the upper central incisor markings are larger than the adjacent lateral incisors simultaneously the four lower incisors are about the same size. As far as the children are concerned, their bite marks can be distinguished by their size that means <3.5 cm and their small tooth mark with spaces among them (Bernstein, 1997). The analysis of the characteristics of each type of teeth offers to the investigators the indispensable documents for the most accurate identification of the culprit. To be more specific incisors produce rectangular injuries and canines cause triangular injuries. But the researchers take into account the individual characteristics of each tooth, namely; fractures, rotations, attritional wear and congenital malformations. When they are recorded in the bite mark they certainly contribute to identify positively the perpetrator. Such documents could be proved useful after the necessary comparison and lead to the guilty person who caused the

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injury (Sweet and Pretty, 2001). Besides such human bite marks from the teeth most of times the researchers observe a central area of bruising that means an extra vascular bleeding caused by pressure from the teeth and it can be seen within the marks from the teeth (Sweet and Pretty, 2001). The skin of victims can most often be the main witness of the attack because investigators can find the majority of the bite marks on it. Such human bite marks can be found on almost all parts of the human body. In case of a sexual attack females are most often bitten on the breasts and legs whereas bites on males are commonly seen on the arms and shoulders (Sweet and Pretty, 2001; Vale and Noguchi, 1983; Pretty and Sweet, 2000). Moreover in cases of self defense, the bites are seen on the arms and hands as a result of the characteristic of the effort of the victim toward off the attacker holding up his arms (Sweet and Pretty, 2001).

Dogs: Dogs are carnivores and they are diphyodont meaning they have two sets of teeth deciduous replaced by permanents (Fig. 1). Although, the exact number can vary, puppies have 28 deciduous (temporary or baby) teeth and adult dogs have 42 permanent teeth. By 24 weeks of age, usually all of the permanent teeth have emerged. A dog has 3 incisors, 1 canine, 4 premolars and 2 molars on one side of the upper jaw and 3 incisors, 1 canine, 4 premolars and 3 molars on one side of the lower jaw (Budras *et al*., 2007).

An indispensable part of the research on dog bites is definitely the hole-and-a-tear effect that is the paradigmatic dog bite. This crucial effect involves multiple tear wounds with adjacent puncture wounds that in the most of the cases is accompanied by missing tissue and claw marks (Santoro *et al*., 2010; Gershman *et al*., 1994; Tong and Pang, 1965). On a victim, who suffers from this kind of effect, the researchers can observe puncture wounds, round holes made by the canine tooth of either the upper or lower jaw on one side serves as an anchor. The other teeth are responsible for stretch lacerations as they cut into the flesh during the process of biting, shaking and tearing (Santoro *et al*., 2010; Tong and Pang, 1965).

The researchers can categorize the wounds caused by dogs into three main groups according to their severity; non-fatal dog bite wounds, severe dog bites that directly or indirectly, lead the victim's death and post mortem lacerations of the victim's body (Santoro *et al*., 2010; Mathews and Lattal, 1994).

Fig. 1: Left: dog's skull. Right: Millimeter measure for scaling inter-dental figures

MATERIALS AND METHODS

Procedure to collect evidence

Human: The forensic investigator ought to follow a procedure recommended by the relating protocol so as to collect adequate evidence; documentation, photographs and saliva swabs. It is strongly recommended a collection and analysis of saliva deposited on bitten or sucked skin, an analysis that is conducted in the laboratory and the method deals with salivary DNA evidence and the growth of bacteria (Sweet and Pretty, 2001; Sweet *et al*., 1997). Impression and prompt medical attention should be provided for the living victim since human bites have a higher potential for infection than animal bites (Sweet and Pretty, 2001).

Dogs: In case of dog bites, the investigator should follow a similar procedure for the collection of the adequate evidence. The 1st basic step includes the examination of the suspected animal for blood and visible traces of evidence from the victim. A sample of DNA from animal's mouth, lips, hair and claws should come next. The animal ought to be taken immediately to a veterinarian to induce vomiting. The vomitus should be examined for tissue, clothing and foreign objects in order to compare to the victim. The quarantine is compulsory in these cases something that will also help us to collect the feces that can be analyzed for the possible existence of bone tissue, clothing and foreign objects to compare to the victim. While the animal is in quarantine the researchers should anesthetize it and make an overall dental examination, take dental impressions (Fig. 2) followed by maxillary measurements (like intercanine width) and detailed

Fig. 2: Impression procedure in a dog: Anesthesia, use of silicon impression material

photography. In case the victim survives the attack, the animal should be tested for rabies (Silver and Souviron, 2009; Santoro *et al*., 2010). Following that procedure signifies the prevention of possible misdiagnosis especially in case of absence of eye witnesses.

Treating bites: After an attack in a living victim the wounds should be cleaned and irrigated at the 1st operation. The larger wounds used to be covered with polyvinyl alcohol sponge. The wounds that are thoroughly cleaned, irrigated and left to granulate usually be healed without complication. Antibiotics are not generally needed for wounds >2 days old without if there is no sign of infection. Bites may be either from humans or animals (particularly dogs).

About 10-30% of dog bites and 9-50% of human bits lead to infection. Consider that antibiotics for bites involving hands, feet, ligaments, tendons, fractures or for penetrating bites in people with poor immunity, diabetes or cirrhosis. Co-amixiclav (500 mg/125 mg tds for adults and 40 mg kg^{-1} tds doses based on amoxicillin for children) should be given for 5-7 days. If allergic to penicillin then use doxycycline (100 mg bd) and metronidazole (500 mg tds) for those >12 or erythromycin and metronidazole for those under 12 years old. If the wound is obviously infected then antibiotics should be given for 10-14 days. Treatment for tetanus should also be considered in all cases where the skin is breached.

Post-mortem depredation: Despite its unlikely occurrence, post-mortem animal depredation poses a major problem to forensic death research. The phenomenon of postmortem activity to human bodies is mainly caused by rodents and dogs. The researchers can have cases both indoors and outdoors.

In the 1st case, it involves low socioeconomic settings whereas in the second case is more commonly observed among homeless people (Tsokos *et al*., 1999a). The majority of the injuries caused by rodents have a circular shape. The wound margins are scalloped and finely serrated, with irregular edges, with circumscribed 1-2 mm intervals within partly showing protruding indentations up to 5 mm. The upper and lower pairs of the rodent's incisors are responsible for some distinct parallel series of furrows (parallel cutaneous lacerations) that are diagnostic for tooth marks of rodent origin (Tsokos *et al*., 1999a) but these characteristic striae cannot always be found (Tsokos *et al*., 1999a; Haglund, 1992). The most common bitten areas are the exposed and unprotected parts of the body, such as eyelids, nose and mouth and the back of the hands (Tsokos *et al*., 1999a). It has been tracked that when the rodents start gnawing on a certain spot, they continue to gnaw until nearly all skin, soft tissue and muscles thus removing that particular spot. Moreover, structures such as tendons and ligaments are affected and bones are exposed (Tsokos *et al*., 1999a). The researchers can be led to misdiagnosis while having a quick look at such injuries because they give the impression that is made by a sharp-bladed instrument. But the animal presence and activity can be directly proved by documents that the researchers can collect at the scene such as fecal material of rodent origin or rodent hair found next to the corpse (Haglund, 1992; Tsokos and Schulz, 1999; Tsokos *et al*., 1999a). In cases of rodent bite injuries, there are no self-defense injuries or signs of vital trauma on the deceased's body (no evidence of hemorrhage or reddening of the wound) (Clark *et al*., 1991; Tsokos *et al*., 1999a; Ropohl *et al*., 1995). But also more animals like dogs affect the appearance of a corpse they alter the scene surrounding and create post-mortal artifacts (Rothschild and Schneider, 1997; Verzeletti *et al*., 2010).

Postmortem animal bite marks typically feature unmistakable wound edge patterns and abrasions with little or no signs of bleeding and the researchers do not find defense injuries. To identify the animal that is responsible for that the researchers do serological species analysis. For a serological analysis, the researchers should check a human body specimen for species diagnostic markers, namely human, dog, cat and rabbit antigens in order to assess whether biological animal traces are present on the corpse. The advantage of such tests is their lower cost and their quicker results compared to a DNA analysis despite the fact that it is less sensitive method (Tsokos *et al*., 1999b; Ferri *et al*., 2009; Verzeletti *et al*., 2010).

RESULTS AND DISCUSSION

Animal bites cause 1% of all emergency cases and 1-2% of these patients require hospitalization. The most frequently affected are children aged up to 6 years (52.8%). The 80-85% of all bites are dog bites, 10% are cat bites and 5-15% are other animal bites (Knezevic *et al*., 2006). Bite wounds located at the face, neck and head are most frequent in children (73%) whereas only 30% of adult dog bite traumas are located at the head and the neck (Weiss *et al*., 1998). It is written that some factors are responsible for the attacks on humans by dogs. Some of them are a possible genetic predisposition toward aggressiveness, male gender intact reproductive status, defence of territory or puppies, lack of social interaction with humans, age, size and the behaviour of victims (Santoro *et al*., 2010). Dogs can also instinctively act as a group and become more aggressive in these terms. Once a dog started biting, other dogs join in. Pack attacks can possibly cause more serious injuries than attacks by a single dog. The pack attack can become responsible for greater number of wounds and is also likelihood that social facilitation and pack instinct will prolong or escalate

the attack (Kneafsey and Condon, 1995; Borchelt *et al*., 1983; Santoro *et al*., 2010). As far as cases of post-portem activity the dogs and the other animals are probably excited by the smell and taste of blood or dead tissues (Santoro *et al*., 2010). There is another possibility of skin marks that can resemble bites and can cause a difficulty in differential diagnosis. One arched marks that can mimic bite marks are skin injuries with shoe heels, ringworm; hoof marks from farm animals and burns caused by paddles during cardioversion simulate toothless bitemarks, creating a red-brown circular injury (Harvey, 1976). These types of bite marks are usually larger in size, located in different spots in skin of the chest.

Diagnosis may occur by history and the lack of teeth marks can set the proper recognition of the mark. Bitemarks that may be distorted and produce multiple lacerations are likely to be mixed up with other skin marks. For example, cat bites have special characteristics and usually are accompanied with scratches (Vale and Noguchi, 1983; Bernstein, 1985; Sperber, 1990; Silver and Souviron, 2009).

Doubtless a dog attack will have psychological and physical sequels to the victim (Shewell and Nancarrow, 1991). The attack has more negative results especially when the attack refers to children, something that happens very often (Kneafsey and Condon, 1995; Wiseman *et al*., 1983; Dwyer *et al*., 2007; Santoro *et al*., 2010; Avis, 1999). But a dog attack does not react on only to children but as it is also written dog attacks make many parents express feelings of guilt and shame (Shewell and Nancarrow, 1991). When the angry dogs bite they move their heads vigorously (Santoro *et al*., 2010; Thompson and Svitek, 1973) and the force delivered by their jaws when biting can be as high as 450 lb in 2 (Santoro *et al*., 2010). That movement of biting tears tissue and cause the characteristic trauma called hole and tear wound (Kneafsey and Condon, 1995; Tong and Pang, 1965; Santoro *et al*., 2010). That term refers to multiple wounds that sometimes are fatal. Those pattern of punctures, lacerations and avulsion of skin and soft tissues vary in size and depends on the particular animal and specific surface bitten (Santoro *et al*., 2010; Dorion, 2005). Also, bone tissue damage caused by carnivores is ragged and leaves behind a series of tooth sized pits and indentations along the margin (Santoro *et al*., 2010; Bonnichsen and Will, 1980).

Moreover, the most frequent sites of injury are on the head, face neck (Dwyer *et al*., 2007; Santoro *et al*., 2010). Whereas referring to bites in younger children (<6 years) it is written they can be found mostly to the head, face and neck and for older children (>6 years) also to the lower limbs (Dwyer *et al*., 2007). That means that exist some age-specific anatomical locations for dog bite injuries alongside withthe growth stageofthe body (Dwyer *et al*., 2007). Lesions usually involve a combination of biting, clawing and crushing forces resulting in wounds with a characteristic pattern of punctures, lacerations and avulsion of the skin and other soft tissues (Murmann *et al*., 2006; Santoro *et al*., 2010). The normal distance between the maxillary canine teeth in adult humans is 2.5-4.0 cm and the canine marks in a bite will be the most prominent or deep parts of the bite. Bites produced by dogs and other carnivorous animals tend to tear flesh whereas human bites compress flesh and can cause abrasion, contusions and lacerations but rarely avulsion of tissues.

Furthermore, human bites reflect the canine teeth but they usually include the incisors as well due to the relative flateness of the edges of human teeth when compared to those of animals. Something that should be included in the diagnose procedure is that carnivores have six incisors and two very large canines per arch, compared to human arches that have only four incisors and much smaller canines (Murmann *et al*., 2006). As far as human bites the most common methods to determine if the suspect's teeth caused the bitemark include techniques to compare the pattern of the teeth (shape, size, position of teeth) with similar characteristics present in life-sized photographs of the injury using transparent overlays.

The most accurate techniques are a method using a computer (Sweet *et al*., 1998; Sweet and Pretty, 2001), the comparison of the suspect's photographs with the bitemark, comparison of test bites produced from the suspect's teeth with the actual bitemark and the use of radiographic imaging (Rawson *et al*., 1979; Sweet and Pretty, 2001) and scanning electron microscopy (David, 1986; Sweet and Pretty, 2001). Also, one recently added method uses the high intensity alternative light sources and lasers to locate stains from bodily fluids at the crime scene, saliva remains deposited on skin even though there are no marks from teeth (Sweet and Pretty, 2001). Referring to animal bites and especially to dog bites the verification can occur if there is eye witness or after a morphological comparison and the confirmation of the results has to do with the measuring of the intercanine distance (Santoro *et al*., 2010).

Three are the most used maxillary measurements: the Maximum Canine Width (intercanine width) (MCW) that is commonly used in cases of deep bites, the canine cusp Tip (Tip) and the Mesial Bone Height (MBH) (Murmann *et al*., 2006).

To identify which of the suspect dogs bore the greatest responsibility for the injuries sustained; the researchers make a comparison between the cutaneous samples where the injuries are located and the dental casts and after that we can verify the compatibility of the marks.

CONCLUSION

Despite the fact that many attacks by dogs happen so frequently, dogs will continue to be kept as pets, for hunting, for guard duties and for racing. Most of the responsibility for such attacks lies with the dog owner who should keep under control dogs with a history of threatening humans. Behavior modification techniques are considered to be the appropriate solution to avoid those attacks caused by dogs but on the same time coping with the problem of aggressive dogs may have as a result a devastating injury (Kneafsey and Condon, 1995; Voith, 1981; Dwyer *et al*., 2007; Tsuji *et al*., 2008).

RECOMMENDATIONS

Further measures need to be adopted such as adequate training, keeping young children away from dogs, sterilization, better enforcement of existing regulations and standardized monitoring of bite rates. Dogs, especially those with a history of threatening any human being, should not be allowed to run free or interact with people, unless they are under control (Kneafsey and Condon, 1995; Borchelt *et al*., 1983). In addition, controlled investigations of further risk and protective factors are also needed (Santoro *et al*., 2010).

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