


Comparison of the bite mark pattern and intercanine distance between humans and dogs

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Introduction

Bite mark analysis and identification combine as the scientific link between a bite mark and the potential biter. Bite mark analysis is currently contentious. It is a vital area within the highly specialized field of forensic science and constitutes the most common form of dental evidence presented in criminal court.^[1]

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Abstract

Background: Bite marks show uniqueness due to specific characteristics and arrangement of teeth, but when it comes to bite mark analysis, it is complicated by numerous factors such as animal bite, abuse etc., Humans and pet animals (dog) bite marks analysis is by far the most demanding and complicated part of forensic dentistry. **Aim:** To analyze and compare bite marks of humans and the pet animals (dog) using indirect method, so as to assess its usefulness and application in forensic odontology. **Materials and Methods:** 40 samples including 20 humans (10 males and 10 females) and 20 dogs of different breed were included in the study. Bite registration of all the samples were obtained on modeling wax and intercanine distance were measured. Data were analyzed and results were tabulated. **Results:** Arch size and intercanine distance showed variable differences among humans and on average dogs showed more intercanine distance and arch size. Among dog breeds larger dogs showed larger variables when compared to smaller dogs. **Conclusion:** Assessment of bite marks evidences made by animals needs further investigation so that it can be a tool to assist the justice system to answer crucial questions.

Key words: Bite, dog, forensic, human, uniqueness

Animals like dogs are one of the closest species to humans as they have been kept as pets and companions as well as for hunting and guard purpose. Recently the subjects of dog bites have increasingly come to the forefront. The dog is the most common culprit of animal bites on humans. In order to avoid cases of misdiagnosis, the researchers analyze certain characteristics of dog and human bite marks.^[2-5] Careful analysis of the dental characteristics and features of a bite mark may help identify whether the biting injury was self-inflicted, caused by an aggressor, an animal or at the very least, may exclude a suspect. One of the parameters of the investigation is the measurements of the intercanine distance (ICD), as the impressions of the anterior teeth are usually the most evident and likely to be measurable.

Bite mark analysis is based on the assumptions that dentition is individually unique and that uniqueness is replicated on

the bitten surface. Hence, we aim to analyze the ICD in the bite marks of humans and dogs and also comparing their bite marks so as to assess the usefulness and its application in Forensic Odontology. We also highlight that this is being the first study in India considering dogs of different breeds.

Materials and Methods

The study included a total of 40 samples comprising 20 humans and 20 dogs. Of 20 humans 10 were males and 10 females. Twenty dogs were selected by their breeds with 5 dogs in 4 different breeds included were (a) Pomeranian, (b) German shepherd, (c) Doberman, (d) Indian.

Modeling wax was used to record the bite marks of humans and the modeling wax was placed in the mouth and upper and lower bites were taken [Figure 1]. Using the calipers the ICD was measured. The bites registered on the modeling wax were filled with a temporary restorative material i.e. zinc oxide eugenol (ZOE) and were subjected for the radiograph for the inverted image to assess-the arch

shape and ICD using indirect digital imaging and Diagora software version 2.7.103.437 [Figures 2 and 3].

Acepromazine was used to sedate the dogs. After sedation the modeling wax was placed in the mouth and the bite of upper and lower jaw were recorded [Figure 4]. The ICDs on wax and on inverted image were recorded as recorded in humans [Figures 5 and 6].

The data of the both the humans and dogs were tabulated and were subjected for statistical analysis which included independent *t*-test and ANOVA with *post hoc* Dunnett test keeping male or female as reference.

Results

Humans

The age range observed in human sample (20) was 21-31 years. The arch size of males ranged from 30 to 45 mm and of females ranged from 25 to 45 mm. The arch shape was predominantly oval with four samples showing elliptical or circular or

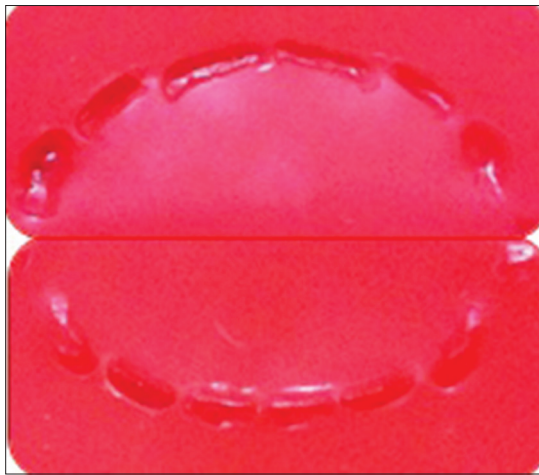


Figure 1: Photograph showing human bite marks on modeling wax

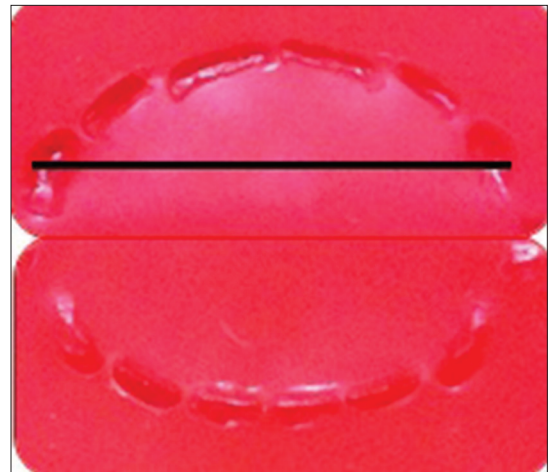


Figure 2: Intercanine distance measurement on wax with human bite mark

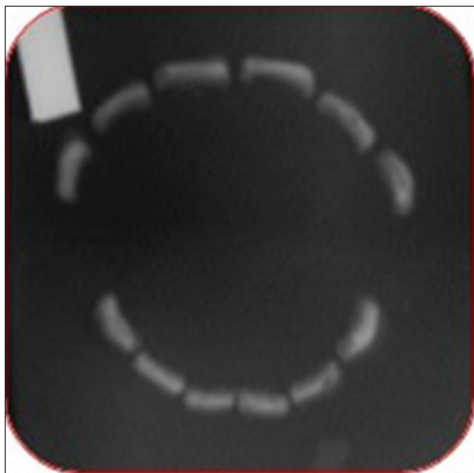


Figure 3: Intercanine distance measurement on x-ray using Diagora software version 2.7.103.437

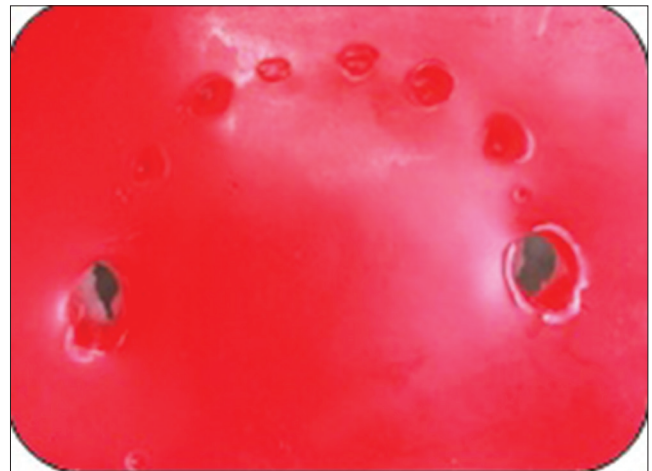


Figure 4: Dogs bite mark on modeling wax

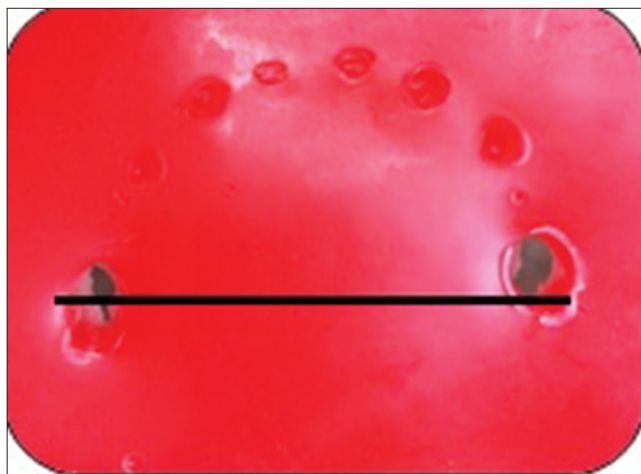


Figure 5: Intercanine distance measurement on wax with dog bite mark

doughnut shape. The incisor morphology observed in both males and females showed rectangular shapes whereas canine showed triangular or trapezoidal shape. ICD measured on wax and on x-ray showed range of 36-42 mm in the maxilla of males and 34-41 mm in females with a standard deviation of 0.16 whereas mandible showed 26-33 mm in males and 26-33 mm in females with a standard deviation of 0.13.

Dogs

Of 20 dogs, the overall arch size of dogs ranged from 30 to 55 mm with arch shape showing circular to oval shape. Incisor morphology of dogs was found to be oval to rectangular whereas canine morphology showed oval to round shape. ICD on wax showed 36-44 mm in maxilla and 28-39 mm in mandible, with a standard deviation of 0.31 whereas on x-ray it showed 31-41 mm and 28-39 mm in maxilla and mandible, respectively, with a standard deviation of 0.29.

When the four breeds of dogs were compared the arch shape, incisor and canine morphology appeared to be same but the difference was observed in the arch size with Poomarian showing smallest and German shepherd showing the largest. The ICD on wax as well as on x-ray showed increase in the measurement from Poomarian to Doberman to Indian to German shepherd.

A comparison of the parameters between different breeds of dogs and human samples using ANOVA with *post hoc* Dunnett test showed human females with smaller arch size and ICD when compared to German shepherd, Doberman and Indian but was more than Poomarian. The human male sample showed larger arch size and ICD compared to Doberman and Poomarian, but smaller when compared to German shepherd and Indian [Tables 1 and 2].

Discussion

The lesion produced by bites are objects of forensic scrutiny and considered first to determine their origin whether they

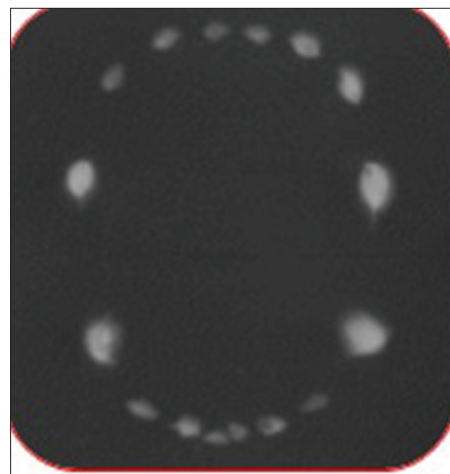


Figure 6: Intercanine distance measurement on x-ray using Diagora software version 2.7.103.437

were formed by the animal or human. Animal bites cause 1% of all emergency cases and 1-2% of these necessitate hospitalization. The most frequently affected are children aged up to 6 years (52.8%). The 80-85% of all bites is dog bite; 10-15% is of other animals as suggested by Stavrianos *et al.*^[2-5]

In India, 2-19 per 1000 people per year shows the annual incidence of animal bites. The survey standards were fixed at 90% confidence level and 10% limit of error. The biting animals were predominantly dogs (91%) and were mostly stray, both in urban and rural areas. Majority of bite victims belonged to the poor and low-income group and this was observed to be more pronounced in rural areas. The incidence of dog bite was observed to be more in children than adults. Hence, the present study is put forward to analyze and compare the dog bite with that of human bite and also to assess their role in forensic investigation.^[2,6-10]

Bite marks display unique characteristics of contacting tooth surfaces or details related to palatal or lingual tooth surfaces leaving imprints on soft tissues. Human bite marks are mostly induced during assault, rape, murder, abuse and less frequently of robbery. Human bite mark presents as diffuse or specific bruises, depending on if there is a single bite or multiple, overlapping bites. Typically, a human bite mark comprises two opposing U-shaped arches separated by open spaces. A hematoma may occupy the center space of the bite mark, caused by soft tissue compression during biting action. The present study assessed arch size, shape, incisor and canine morphology and ICD measurement on wax and X-ray using the indirect method and observed difference in ICDs among males and females which was correlated with the literature.^[7,8,11]

Animal like dogs are carnivores and are diphyodont. An indispensable part of the research on dog bites is the hole-and-a-tear effect which is the paradigmatic dog bite.

Table 1: ANOVA with post-hoc Dunnett t test using Human male as reference

Recording methods	Breed										P	Post-hoc test
	Poomarian		German shepherd		Doberman		Indian		Human male			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
max_wax	3.48	0.22	4.14	0.21	3.66	0.09	3.94	0.33	3.87	0.17	<0.001	Human male>Poomarian
mand_wax	3.16	0.25	3.66	0.19	3.38	0.11	3.48	0.26	3.14	0.26	0.003	German shepherd>Human male
max_x-ray	3.46	0.23	4.14	0.25	3.60	0.10	3.90	0.30	3.84	0.18	<0.001	Human male>Poomaria
mand_x-ray	3.16	0.26	3.68	0.18	3.24	0.15	3.44	0.23	3.02	0.22	<0.001	German shepherd, Indian>Human male

SD: Standard deviation

Table 2: ANOVA with post-hoc Dunnett t test using human female as reference

Recording methods	Breed										P	Post-hoc test
	Poomarian-cani		German shepherd		Doberman-cani		Indian-canis		Human male			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
max_wax	3.48	0.22	4.14	0.21	3.66	0.09	3.94	0.33	3.77	0.18	0.001	German shepherd>Human female
mand_wax	3.16	0.25	3.66	0.19	3.38	0.11	3.48	0.26	3.09	0.14	<0.001	German shepherd, Doberman, Indian>Human female
max_x-ray	3.46	0.23	4.14	0.25	3.60	0.10	3.90	0.30	3.77	0.16	<0.001	Human female>Poomarian German shepherd>Human female
mand_x-ray	3.16	0.26	3.68	0.18	3.24	0.15	3.44	0.23	3.01	0.19	<0.001	German shepherd, Indian>Human female

The head and neck are the most frequent sites of injury in victims bitten by dogs and bites occasionally result in death. There are few studies on injuries left by dog bites in human. It is an important topic, due to fatal attacks by aggressive breeds of dogs, most of the fatal cases occur in children.^[11,12] Hence, the present study included four different breeds of dogs (5 Poomarian, 5 German shepherd, 5 Doberman and 5 Indian) which are commonly kept as pets. The study samples of dogs were also assessed for the arch size, shape, incisor and canine morphology, ICD measurement on wax and x-ray. The result showed variability among the dogs which could be due to size and shape of skull related to the different breeds.

ICD measurement is considered to be the important parameter as the impression of the anterior teeth is usually the most evident and likely to be measurable. In our study an inverted image of the bite marks were taken and the ICD was measured on the radiograph. The method was used as it presents (a) no risk to the participants and (b) confidentiality of identity was conserved. The variability of the ICD measurements found in both humans and dogs had similar values, but on average measurements for dogs are larger.^[2,3,5,6,13,14] The variabilities in the parameters observed in our study among human bite and dog bite marks are summarized in Table 3.

The dentition and morphology of the humans and dogs are different but when the bite is induced these parameters may help to differentiate the bite mark and analyze and assess the culprit for the bite. The present study highlights the inclusion of different breeds of dogs and the variability in the arch size and intercanine measurements which appeared to be larger on average when compared to humans which could be attributed to the dog's weight, size and shape of the skull.^[2,5,7,8]

Table 3: Comparison between human and dog dentition

Parameters	Human bite	Dog bite
Tooth numbering system	FDI (Federation Dentaire Internationale)	Modified triadan tooth numbering system
Arch size	25-45 mm	30-55 mm
Arch shape	Oval, elliptical and few doughnut shaped	Circular
Incisor morphology	Rectangular	Oval to rectangular
Canine morphology	Triangular or trapezoidal	Oval or round
Inter canine distance (ICD)	29-39 mm	32-43 mm

Knowledge of this uniqueness may enable greater scientific assurance in establishing the differential diagnosis of bite marks. The serious nature of the bite injury often dictates utmost level of forensic standards should be applied and the individuals trained and experienced in the recognition, collection and analysis of this type of evidence is needed.

Conclusion

Dentition refers to the number and arrangement of different types of teeth in animal. The dentitions of different animals vary according to their diets. Bite mark can be used to identify the animal or the person causing the bite. Teeth bite marks can be compared by a direct or indirect method. Key feature include width and rotation of each tooth, teeth gap width, distance between teeth. Teeth induce the bite marks on the victim.

Despite the fact that many are attacked by dogs, it happens so frequently, it is mandatory to record and identify the bite marks in order to find the potential biter. Though the

advanced methods like DNA analysis which gives more accurate results are least followed due to its non-feasibility and cost efficiency. Intercanine distance is a simple reliable parameter to differentiate between bite marks and can be produced by humans and domestic dogs of different breeds using the indirect method.

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