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Research Article

Bite Wounds in Dogs: A Retrospective Study of 467 Cases Presented at a Veterinary Teaching Hospital

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Abstract

Epidemiological characteristics and severity of the wounds can vary depending on the environmental factor and the owner's socioeconomic status. This study retrospectively assessed dogs with bite wounds inflicted by another dog presented at a Veterinary Teaching Hospital. A total of 467 patients were identified, 55.2% males and 44.7% females, aged from 0.3 to 264.3 months and weighing 0.3-57.5 kg. Adult male dogs (18 to 84 months of age), had the highest percentage of bite wounds. The crossbreed dogs (n = 284), were the most bitten, and pinschers (n = 43), and poodles (n = 37), were the most frequently bitten breeds of purebred dogs. Small-sized dogs (n =293), were those that most suffered bite injuries. Regarding the living environment, 81.3% of the dogs came from an urban area and 18.6% from the rural area. The season of the year that showed a lower percentage of bite wounds for both male and female dogs was autumn. The majority of the dogs had bite wounds evaluated 24-72 hours after injury. The bite wounds on the body area firstly occurred in multiple sites (28.9%), followed by the head (20.6%), and neck (22.3%). The bite wounds were treated by second intention healing in 91.9% of the cases, and primary closure was carried out in 7.1% of patients. Euthanasia was necessary for five dogs due to the severity of the injuries. In conclusion, the small-sized crossbreed adult dogs living in an urban environment were the most susceptible to suffering bite wounds located in multiple sites.

INTRODUCTION

Bite wounds account for around 10% to 15% of all trauma cases in small animals, but the actual incidence is still unclear [1,2]. The canine bites promote tissue damage by a combination of forces, including shearing, tension, and compression [1]. Besides, the aspect of bite wounds may be misleading since the degree of skin damage is not a predictor of the severity and depth of tissue damage [1,3]. In general, open and closed bite wounds should be considered contaminated, because the wound may contain microbial flora of the attacking dog's oral cavity and victim's skin, as well as foreign material from the environment [1,4].

Pasteurella multocida is an important pathological agent in canine wounds, but *Staphylococcus* and *Streptococcus* are also commonly found [5]. There are also reports of mixed infection with aerobic and anaerobic bacteria [3]. In a study of 50 dogs with 104 bite wounds, the infected wounds presented *Pasteurella canis* and *Pyogenic streptococci*, and the contaminated wounds presented *Bacillus* spp., *Actinomyces* spp. and oral *Streptococci* [6]. In addition, the transmission of the rabies virus through bites must be considered especially in unvaccinated animals [1,4].

According to the severity, location, and time of occurrence, the bite wounds can promote a wide variety of problems, including those potentially life-threatening [3-5]. For example, limb fractures may occur due to the teeth of the attacking animal [1]. Regarding the thorax and abdomen, the dog bites can penetrate these cavities, and injury to internal organs can be directly or indirectly caused [1,2,7]. Also, bite wounds over the back can induce renal injury [2]. Neurological damage can be the result of bite wounds affecting the spinal cord or cranial vault, and although less frequent, hemorrhage may result from a lacerated blood vessel [1,4]. The location of bite wounds is probably related to the target population [4]. However, small-sized dogs are particularly at risk, because a large dog can grasp most portions of the small dog's body [2].

Epidemiological characteristics and severity of the bite wounds can vary depending on the environmental factor and the owner's socioeconomic status. Therefore, this study retrospectively assessed dogs with bite wounds inflicted by another dog presented at a Veterinary Teaching Hospital, aiming to identify the most susceptible individuals and some aspects of the bite wounds.

MATERIALS AND METHODS

Animals and study design

This study was approved by the Institutional Ethics Committee for the Use of Animals (0086/2019– CEUA). The medical records of dogs with bite wounds, presented to a veterinary teaching hospital, were retrospectively evaluated over a 5-year period. Data obtained from these files included information regarding patient signalment (breed, age, sex, body weight), the income of the owner (low, medium, high categories), living environment (urban or rural), and year and seasons of the year when the wound occurred. Three age groups were determined: young (up to 18 months), adult (18 to 84 months of age), and senior (over 84 months of age). In addition, the dogs were distributed according to body size/body weight (small: up to 10.9 kg; medium: 11-20 kg, large: more than 20 kg). The wound was evaluated based on time lag from injury to admission (from 0 to 6 hours, from 24 to 72 hours, and over 72 hours), location on the body area (head, neck, back, thorax, abdomen, perineum, forelimbs, hind limbs, tail, and multiple sites), treatment (conservative, surgical), mortality and other complications. Other injuries caused by the bite wounds were also evaluated.

Statistical analysis

The normality of the data was checked by the Kolmogorov-Smirnov test. The Chi-square test was used to compare categorical variables and the Mann-Whitney U test or Kruskal-Wallis test for comparison of continuous variables (body weight, age), taken into account if appropriate with data aggregation. Standardized residuals were analyzed with the Chi-square test to identify those specific cells making the greatest contribution to the Chi-square test results. Residuals greater than 1.96 (or less than -1.96), are commonly accepted as a sufficiently large deviation between the observed and expected values [8]. The significance level was set at 5%. Statistical analysis was performed with commercial statistical software (Graphpad Prism 8.3.1®, San Diego, CA).

RESULTS

A total of 467 patients were identified, 55.2% males (n = 258; young = 75, adult = 111, senior = 72), and 44.7% females (n = 209; young = 48, adult = 83, senior = 78); aged from 0.3 to 264.3 months (mean ± SD, 61 ± 52.2 months); and weighing 0.3-57.5 kg (mean ± SD, 10 ± 8 kg). The income of owners was classified as 29.1% low (n = 136), 10.7% medium (n = 50), and 60.17% high (n = 285). The males (median 8.0 kg), had statistically ($p = 0.03$), greater body weight than females (median 6.6 kg). The females (median 60 months), had statistically ($p = 0.01$), a higher median age than males (median 48 months). The body size range obviously differed statistically between the groups ($p < 0.0001$), with lower body weight in small dogs compared to medium and large dogs, as well as lower body weight in medium dogs compared to large-sized. Age did not show significant differences ($p = 0.4$).

Crossbreed represented 60.8% (n = 284) of the dogs. The 39.1% (n = 183) purebred dogs included: pinscher (n = 43); poodle (n = 37); shih tzu (n = 14); Lhasa Apso (n = 14); dachshund (n = 10); Yorkshire (n = 9); pitbull (n = 8); blue heeler (n = 7); border collie (n = 6); Maltese (n = 6); German shepherd, Belgian shepherd, shar-pei, basset hound, Brazilian terrier, Labrador retriever, bull terrier, Pekingese and boxer (each one, n = 2); Dalmatian, chow-chow, bulldog, Australian cattle dog, Doberman pinscher, golden retriever, Japanese spitz, Cane corso, Rottweiler, and Bernese mountain dog (each one, n = 1).

Regarding living environment, 81.3% (n = 380), of the dogs came from urban area, and 18.6% (n = 87), from rural area. There was no association between sex and the living environment (rural or urban) ($\chi^2 = 0.6$, $p = 0.6$). The distribution of the bite wounds across the years were 3.8% (n = 18), 23.1% (n = 108), 22.3% (n = 104), 26.8% (n = 125), and 24% (n = 112), respectively, in 2015, 2016, 2017, 2018, and 2019. Based on the four seasons of the year, the bite wound occurrences were: spring - 29.5% (n = 138), - winter - 28.7% (n = 134), - summer- 26.3% (n = 123), - and autumn - 15.4% (n = 72). There was no association between sex and seasons of the year ($\chi^2 = 2.1$, $p = 0.6$).

The time from injury to admission determined according to number of animals was as follows: 28.9% (n=135), dogs from 0 to 6 hours, 36.6% (n=171), dogs from 24 to 72 hours, and 18.6% (n=87), dogs over 72 hours. In a total of 15.8% (n=74), cases, the owner was unable to determine the injury time. There was no case from 7 to 24 hours. The location of the bite wounds were not associated with dog's size ($\chi^2 = 17.6$, $p = 0.5$), as well as age groups ($\chi^2 = 21.3$, $p = 0.3$). Table 1 shows the location of the bite wounds on the body area, according to the sex and the body weight of the dogs.

The bite wounds were treated by second intention healing in 91.9% (n = 429), of the cases. Primary closure of bite wounds was carried out in 7.1% (n = 33), of patients. A total of 1.1% (n = 5), of the dogs were euthanized, due to the severity of injuries, such as evisceration of the intestines for more than 48 hours, shock, sepsis, and airway involvement. The most commonly used antibiotics were cephalosporins (cephalexin, cephalothin, or ceftriaxone), generally associated with metronidazole, and followed by amoxicillin and clavulanate combination. Wound swab culture was not routinely performed for the majority of cases.

The immediate or delayed complications of the bite wounds were found in nearly 25.5% of the cases, including hemorrhage (n=25), subcutaneous emphysema (n=4), infection (n=18), necrosis (n=15), myiasis (n=14), abscess (n=34), and phlegmon (n=9). Systemically, cases of hypovolemic shock (n=3), and septicemia (n=5), were seen. There was no association between sex and wound complications ($\chi^2 = 0.07$, $p=0.8$). No association between age groups (young, adult, and senior), and the presence or absence of wound complications ($\chi^2 = 0.1$, $p=0.9$), was found. However, body size was associated with wound-related complications ($\chi^2 = 16.7$, $p=0.0002$), with a lower frequency in small dogs and a higher in large dogs. In addition, the time from injury to admission was associated with wound complications ($\chi2 = 39.2$, $p < 0.0001$); the lower frequency of complications occurred from 0 to 6 hours, and the higher frequency over 72 hours.

Other lesions associated with bite wounds included: fractures of the forelimb (scapula, n=2; humerus, n=1; radius and ulna, n=6; ulna, n=1; metacarpus, n=1), hind limb (femur,

Table 1: Location of the bite wounds on the body area (number and percentage) in 467 dogs, according to sex and body weight.

Body area	Number of dogs (Percentage)	Females	Males	Small dogs (up to 10.9 kg) N = 293	Medium dogs (11–20 kg) N = 123	Large dogs (> 20 kg)\ N = 51
Head	96 (20.5%)	44	51	62	25	09
Neck	104 (22.23%)	55	49	73	22	09
Back	08 (1.7%)	06	02	07	01	-
Thorax	26 (5.6%)	07	19	19	05	02
Abdomen	30 (6.4%)	08	22	21	05	04
Perineum	01 (0.2%)	01	0	-	01	-
Forelimbs	32 (6.8%)	10	22	14	15	03
Hind limbs	30 (6.4%)	16	14	19	08	03
Tail	05 (1.1%)	01	04	02	03	-
Multiple sites	135 (28.9%)	60	75	76	38	21

n=2; tibia, n=3; fibula; n=1; metatarsus, n=1), rib (n=4), and facial bones (mandible, n=19; maxilla, n=1; zygomatic , n=2); dislocation (hip joint, n=2; temporomandibular joint, n=1); eye lesions (eye protrusion, n=14; hyphema=2; corneal ulcer, n=1; chemosis, n=1); thoracic injuries (pulmonary contusion, n=5; pneumothorax, n=5; pneumomediastinum, n=1; sternal perforation, n=1; pulmonary laceration, n=1; flail chest, n=1); neurological injuries (traumatic brain injury, n=10; spinal cord injury caused by vertebral fracture and/or dislocation, n=11); rupture (trachea, n=5; larynx, n=1; esophagus, n=1; bladder, n=1; jugular, n=2); dental fracture (n=4); exposed bone without presence of fracture (n=4); evisceration of abdominal contents (n=6); eventration of abdominal viscera (n=5), otohematoma (n=5); muscle contusion (n=3); and lesions with only one case (tongue necrosis, abdominal wall hematoma, rectal prolapse, joint infection). There was no association between sex and these other lesions (χ^2 = 0.8, p=0.4). However, they were associated with the dog's age (χ^2 = 6.7, p=0.04), with a higher probability for these complications in young dogs. Also, the dog's size was associated with other lesions (χ^2 = 19.6, p<0.0001); small dogs had a higher frequency of these complications, and medium and large dogs showed a lower frequency than expected for this association. The time from injury to admission did not influence the occurrence of these complications (χ^2 = 5.0, p=0.08).

DISCUSSION

The large number of dogs examined in the present study indicated owned dogs that are inadequately supervised or are allowed free-roaming since most of the male and female dogs with bite wounds (81.37%), lived in the urban area. In addition, the high annual occurrence of the cases, showing no tendency to regress, indicates a need for improved control by public health departments.

Adult male dogs (18 to 84 months of age), had the highest percentage of bite wounds. A study of bite wounds in 105 dogs performed in a veterinary school also showed that male dogs were more affected than female dogs, but the median age was 2 years (range = 1-13 years)[9]. The predominance of male dogs has been attributed to possible hormonal influence, which favors inter-male aggression and aggressive sexual interaction [10,11].

The season of the year that showed a lower percentage of bite wounds for both male and female dogs was autumn. Although there was no association between sex and seasons of the year in the present study, prospective studies to identify causes or risk factors, such as the presence of females in estrus, even considering that female dogs have a monoestrous and typically non-seasonal pattern [12] will be necessary.

Small-sized dogs (n=293), were the most affected by bite injuries in the current study. Similarly, in a study of 185 dogs with bite wounds evaluated in a veterinary school, there was a predominance of small dogs (≤10kg), which suffered multiple and severe injuries [10]. Small-sized dogs were also considered to be at higher risk for multiple and more serious injuries in a study with 114 cases [9], and in a series of 12 bite wounds was found that all were small breed dogs and most of them had been bitten by large dogs [13]. In the present study, small dogs had a lower frequency of wound-related complications, but a higher percentage of other complications represented most by fractures, which had a higher probability of occurrence in young dogs.

The crossbreed dogs (n=284), were the most common in the present study, and pinschers (n=43), and poodles (n=37), were the most frequently observed breeds of purebred dogs. In another study of dog bite wounds, pinscher, Pekingese, and small terrier breeds were significantly represented, which was attributed to fighting nature and size that make them prone to more severe injury [10].

The majority of the dogs had bite wounds evaluated 24-72 hours after injury. This is an important risk factor since bite wounds are always considered contaminated [1,4]. A delay of more than 6 hours in the wound treatment favors bacterial growth and tissue infection [14]. As expected, the lowest frequency of wound complications in the present study occurred from 0 to 6 hours from injury to admission and the highest frequency over 72 hours. However, age and sex were not associated with these complications, reinforcing the importance of the time from admission to treatment.

The most used antimicrobials in the present study were ß-lactam antibiotics (Cephalosporins and Amoxicillin-Clavulanate), generally associated with systemic Metronidazole.

A limitation of this study is that the wound cultures were not performed in the great majority of cases. Although 60.17% of the dogs belonged to a high-income category, they refused to perform it because of the high cost of the exam. A study that evaluated microbiological population and antimicrobial susceptibility of bite wounds in dogs showed that no single antibiotic was effective against all bacteria; however, Ampicillin, Amoxicillin, Cephalexin, or potentiated sulfonamide have been suggested for empiric use [6].

The bite wounds on the body area occurred in first place in multiple sites (28.9%), followed by the head (20.6%), and neck (22.3%), and had no association with dog's size or age groups. On the other hand, in a prospective study of bite wounds in 37 dogs was verified that 57% of wounds were classified as the most severe, and neck, limbs, head, chest, shoulder region, and abdomen were the most frequent regions of injury, but 86% of the cases the wounds occurred in multiple locations [15]. In turn, the thorax, head, neck, and extremities of the limbs and tail were the most common wound locations in a retrospective study of 185 dogs with bite wounds [10].

Euthanasia was performed in five dogs in the present study due to the severity of the injuries. Bite wounds can cause severe systemic effects if vital organs or systems are involved, including damage to the cranial vault, spinal column, or thoracic wall, among others [1]. Except for airway involvement, the other injuries that culminated in euthanasia getting worse because of the delay to seek specialty care. There was an 11% mortality rate in a study of bite wounds in 185 dogs, eight dogs were euthanized, and 13 died [10].

Complications such as myiasis, abscess, phlegmon, and infection were also related to delay in presentation after injury. In turn, two of the three cases of shock and five of septicemia were related to wounds located in multiple sites. Systemic effects in dogs with multiple severe wounds have been related to systemic inflammatory response syndrome with disproportionate activation or local control loss of inflammation that favors sepsis development [1,4].

The bite wounds located on the forelimbs and hind limbs represented 13.7% of all wounds, and they were related to other injuries resulting from bites, such as fractures and bone exposure. The fractures are usually due to the compressive force exerted by molar and premolar teeth [1]. Pulmonary contusion, pneumothorax, pneumomediastinum, sternal perforation, pulmonary laceration, and flail chest were found due to thoracic injuries in the present study. Subcutaneous emphysema, pulmonary contusion, pneumothorax, and rib separation were radiographically visualized in 11 dogs with thoracic bite wounds [7]. In turn, in a retrospective study of thoracic bites in 54 dogs, thoracic wall discontinuity was the most frequent injury in those undergoing thoracotomy [16].

The treatment of wound healing by secondary intention was carried out in 91.9% of the cases. Although some wounds can be managed by primary closure, as performed in 7.1% of the cases in the present study, the treatment choice must be based on time of injury, contamination degree, severity, and quality of blood supply, among others [4].

Another factor to be considered is that bite wounds can transmit infectious diseases, such as rabies [1,4]. However, the fact was not identified in the current study due to the free-of-charge annual rabies vaccination in the region.

CONCLUSION

The small-sized crossbreed adult dogs living in an urban environment were the most susceptible to suffering bite wounds located in multiple sites. Most bite wounds had a delay in presentation after injury, and most of them healed by the second intention.

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