Risk Factors for Fractures of Dogs in Quezon City, Philippines

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ABSTRACT

A retrospective case-control study was conducted in dogs with bone fractures presented at the Veterinary Teaching Hospital - Diliman Station, Companion Animal Clinic, College of Veterinary Medicine, University of the Philippines Los Baños from January 2016 to December 2021. One hundred sixty-one dogs were diagnosed with bone fractures. Limping was the most common chief complaint with falling from a height being the most common cause. Close, complete, and oblique fractures were the most prevalent fracture type. Around 29.81% of the cases were given medications only and 16.77% were treated with external coaptation. Among the cases treated with external coaptation, only fourteen came back for follow-up with fully healed bone fractures. The mean age of dogs with bone fractures was 2.30 years old and was seen as a significant risk factor regardless of age group. Dogs fed with dry dog food and table food were 0.35 and 0.50 less likely to have bone fractures, respectively. The body weight, body condition scores, and dog breeds were not significant risk factors while the abode of the animal was a significant risk factor regardless whether the animal is indoor or outdoor. Age, diet, and abode were found to be significantly associated with bone fractures.

Keyword: canine, case-control study, fractures, closed reduction, external coaptation

INTRODUCTION

Bone fracture is the discontinuity of the bone with or without the displacement of fragments. It is often associated with damage to the surrounding soft tissues in varying degrees (Mahajan *et al*., 2015). In canine species, bone fracture is one of the most common orthopedic problems presented to veterinary clinics. Several known risk factors for bone fractures in dogs are, in order of frequency, automobile accidents, gunshot injuries, human abuse, and animal fights (Keosengthong *et al*., 2019).

Received: 10-07-2023, Accepted: 06-11-2023, Published online: 08-01-2024
Available at https://e-journal.unair.ac.id/MKH/index

Bone fractures are diagnosed based on the history of trauma and its presenting clinical signs. Radiography, ultrasonography, and computed tomography are the common tools used for assessing the animal's fracture. In some cases, orthopedic and neurological tests may also be performed if necessary (Rrisselada *et al*., 2005; Minar *et al*., 2013).

Retrospective and prospective studies are important to help determine the prevalence of a certain disease in a given region (Chaves, 2014). Information gathered in retrospective studies may increase the efficacy of the treatment of bone fractures by improving the fixation techniques, correction, and stabilization of fractures with higher incidence (Vidane, 2014).

Currently, studies regarding risk factors for bone fractures in the Philippines are very limited. There are no published studies that focus on the risk factors of bone fractures in dogs. This investigation aims to provide up-to-date literature on risk factors for bone fractures that will assist clinicians and practitioners with more suitable and timely management of these conditions. It will also provide additional references regarding the correlation of bone fractures with dog breeds, age, and sex.

MATERIAL AND METHOD

The study followed a retrospective case-control study using the medical records of dogs from the Veterinary Teaching Hospital Diliman Station – Companion Animal Clinic (VTHD-CAC) from 01 January 2016 to 31 December 2021. The cases and controls were selected by convenience sampling.

Microsoft Excel® files containing the patient medical records of the VTHD-CAC from 01 January 2016 to 31 December 2021 were used to collect the data for the study. The phrase "*bone fracture*", and its variations, on the column for the patients' diagnosis were used as the keywords to filter the data for inclusion in the study population. A case was included if a patient was diagnosed with bone fractures through physical examination and radiography. Patients that came in multiple times within the time frame with a similar complaint were considered as one case. The information that was obtained from the medical records was the patient's signalment, history, physical examination, results of radiography, cause of bone fracture (if known), and type of bone fracture based on the extent of damage, number of fracture lines, and shape of the fracture line. Treatments used to address the bone fracture were recorded. For cases where follow-ups were conducted, the information on the progress of the condition was noted.

The patients in the control group included dogs that were examined immediately after the fracture case that was determined to be fit for vaccination and given vaccines. The phrase *apparently healthy* on the column for the patient's diagnosis and the words *rabies*, *DHLPP or both* on the column for

Received: 10-07-2023, Accepted: 06-11-2023, Published online: 08-01-2024
Available at https://e-journal.unair.ac.id/MKH/index

treatment were the keywords to determine qualification as control. Patients with a history of musculoskeletal diseases other than fractures were excluded. The information that was obtained from the control group included the signalment, medical history, and physical examination findings.

The age groups were classified into juvenile (less than one-year-old), young adult (1- 3 years old), mature adult (3-10 years old), geriatric (10 years old and above) (Minar *et al*., 2013; Libradoni *et al*., 2016; Keosengthong *et al*., 2019). The animals were classified according to sex groups as either male or female at the time of fracture diagnosis. The patient's body weight was categorized as mini (below 5kg), small (5-10kg), medium (10-25kg), and large (above 25kg) (Minar *et al*., 2013; Libradoni *et al*., 2016; Keosengthong *et al*., 2019). The body condition score of the dogs was ranked from 1 to 9, with 1 representing an obvious loss of muscle mass and 9 representing massive fat deposits all over the body (Laflamme, 1997; Kealy *et al*., 2002). Diet was classified as dry commercial dog food, wet commercial dog food, mixed dry and wet commercial dog food, and table food. The patient's abode was classified as an indoor dog, outdoor dog, or mixed indoor and outdoor.

The data obtained were encoded, tabulated, and summarized in Microsoft Excel® 2013 software, and then were retrospectively analyzed using descriptive statistics. Relative frequencies of the age, sex, neuter status, breed, weight, body condition score, breed, diet, activity, abode, chief complaint, causes, type of fractures, and treatments used in canine patients that were diagnosed with bone fractures were computed. Odds ratio with 95% confidence intervals at α=5% was used to measure the strength of the association while the chi-square test ($p<0.05$) was used to assess the statistical significance of the association between bone fractures and its categorical risk factors. The estimation of relative risk was considered significant if 95% confidence intervals for odds ratios did not include 1.0.

RESULTS AND DISCUSSION

The study included 322 dogs, 161 of which were diagnosed with bone fractures and the rest was diagnosed as apparently healthy. The total number of cases seen within the course of the study was 45,210 with a prevalence rate of 0.35% for bone fractures. This is slightly lower than the previous study in Thailand, which reported a prevalence rate of 1.70% (Keosengthong *et al*., 2019). This may be due to the differences in the years covered or may be due to an increase in other diseases that may be more common in the Philippines.

The majority of the cause of bone fractures were unknown (56/161, 34.78%) followed by falls from a height (46/161, 28.57%), and vehicular trauma

Received: 10-07-2023, Accepted: 06-11-2023, Published online: 08-01-2024
Available at https://e-journal.unair.ac.id/MKH/index

(37/161, 22.98%). This is opposed to the reports on the previous studies by Minar *et al*. (2013), Uwagie-Ero *et al. (*2018), and Keosengthong *et al*. (2019) where vehicular accidents were the principal cause of bone fracture in dogs. It may be possible that the owners did not observe what caused the fracture, or a bigger percentage of the case population may be housed indoors with less access to the outdoors. Hence, vehicular accidents may be less common. Further, the limited outdoor traffic and activity due to the pandemic lockdown may have decreased the possible causes of vehicular accidents which can lead to fractures.

Appendicular bones were the most affected region, specifically at the dog's forelimbs (73/161, 45.34%). The results of this study showing a forelimb predilection for bone fracture disaffirms the previous studies which reveal a propensity for the hindlimb (Minar *et al*. 2013; Libradoni *et al*., 2016; Keosengthong *et al*. 2019). This may be explained by the difference in the specific bone affected. In this study, the radius and ulna were seen to be the most affected bones. According to Harasen (2003), fractures in the radius and ulna were mostly associated with falling injuries. The result of this study was in contrast with the other previous studies where the femur was reported to be the most affected bone. The variation in the affected bones may be due to the difference in the principal causes of bone fracture.

According to Keosengthong *et al*. (2019), the type of fractures may vary from each case depending on the force of the trauma. In this study, the most recorded fracture types were close (148/161, 91.93%) and complete fracture (32/161, 19.88%). In terms of direction, oblique fracture (22/161, 13.66%) was most prevalent. According to Jain *et al*., (2018), the high incidence of transverse and oblique fractures may indicate that bending or compression forces were the most predominant cause of fracture. The results of this study agree with this statement since bending or compression forces are mostly associated with falling injuries which were the most prevalent cause of bone fracture in this study.

The mean age of dogs diagnosed with bone fractures was 2.30 (±) 1.89. Among the different age groups, juvenile dogs showed the highest occurrence of bone fracture (77/161, 44.10%) (Table 1). Similar findings were reported by previous studies (Minar *et al*., 2013; Keosengthong *et al*., 2019). According to Jain *et al*. (2018), the occurrence of bone fractures in younger dogs may be attributed to their more active behavior and less awareness of environmental hazards as compared to their adult counterparts. Furthermore, younger dogs have thinner cortices which have lesser resistance to trauma, hence making them more prone to bone fracture with less force (Jain *et al*., 2018). This is supported by the results of this study. Based on the chi-square test, it was seen that age has a significant

Received: 10-07-2023, Accepted: 06-11-2023, Published online: 08-01-2024
Available at https://e-journal.unair.ac.id/MKH/index

association with the incidence of bone fracture (table 2). However, there were no significant findings on which age group has higher or lower odds of getting a bone fracture (Table 1). No other studies reported on the odds ratio of bone fractures.

Table 1. Frequency, odds ratios (OR), and 95% confidence intervals (CI) of age groups of dogs with bone fracture and clinically normal dogs from 2016 to 2021 presented to the Veterinary Teaching Hospital Diliman Station – Companion Animal Clinic.

Characteristic	No. of Cases n/N (%)	No. of Control n/N (%)	OR	95% CI
Juvenile (less than 1 year)	71/161 (44.10%)	83/161 (51.55%)	0.74	0.45-1.15
Young adult (1-3years)	28/161 (17.39%)	26/161 (16.15%)	1.09	0.61-1.96
Mature adult (3-10 years)	45/161 (27.95%)	49/161 (30.43%)	0.89	0.55-1.43
Geriatric (10 years and above)	3/161 (1.86%)	2/161 (1.24%)	1.51	0.25-9.16
Unknown	14/161 (8.70%)	1/161 (0.62%)	15.24	1.98-117.32

n: Number of dogs in each characteristic,
N: Total number of dogs with bone fracture or clinically normal dogs,
*: Statistically significant

Table 2. Chi-square test results of the age, sex, weight, body condition score, breed, diet, and abode distribution of dogs with bone fracture and clinically normal dogs from 2010 to 2019 presented to the Veterinary Teaching Hospital Diliman Station – Companion Animal Clinic.

Parameter	X^2	p-value
Age	12.6460	0.0131*
Sex	1.3396	0.8546
Weight	2.0664	0.7236
Body Condition Score	2.7576	0.9866
Breed	29.5077	0.6876
Diet	53.0961	0.0000*
Abode	7.1556	0.0279*

*: Statistically significant since p-value <0.05

Received: 10-07-2023, Accepted: 06-11-2023, Published online: 08-01-2024
Available at https://e-journal.unair.ac.id/MKH/index

Among the dogs diagnosed with bone fractures, 50.93% were males, and 45.96% were females (Table 3). The results of this study are similar to the previous studies by Minar *et al.* (2013) and Keosengthong *et al*. (2019) which reported that male dogs have a higher incidence of bone fracture as compared to females. However, in a study by Libardoni *et al*., (2016) it was stated that there may be no association between sex with the incidence of bone fracture. This is supported by the results of this study where the sex of the animal and bone fracture have no significant association (Table 2); hence, it is not considered a risk factor.

Table 3. Frequency, odds ratios (OR), and 95% confidence intervals (CI) of sex and weight of dogs with bone fracture and clinically normal dogs from 2016 to 2021 presented to the Veterinary Teaching Hospital Diliman Station – Companion Animal Clinic.

Characteristic	No. of Cases n/N (%)	No. of Clinically normal dogs n/N (%)	OR	95% CI
Sex				
Male	83/161 (50.93)	85/161 (52.80%)	0.93	0.60-1.44
Female	74/161 (45.96%)	74/161 (45.96%)	1.00	0.65-1.55
Unknown	5/161 (3.11%)	2/161 (1.24%)	2.55	0.49-13.33
Weight				
Mini (below 5 kg)	49/161 (30.43%)	55/161 (34.16%)	0.84	0.53-1.35
Small (5-10 kgs)	61/161 (37.89%)	51/161 (31.68%)	1.32	0.83-2.08
Medium (10-25 kg)	37/161 (22.98%)	41/161 (25.47%)	0.87	0.52-1.45
Large (25 and above)	10/161 (6.21%)	8/161 (4.97%)	1.27	0.49-3.30
Unknown	4/161 (2.48%)	6/161 (3.73%)	0.66	0.18-2.38

n: Number of dogs in each characteristic,
N: Total number of dogs with bone fracture or clinically normal dogs,
*: Statistically significant

The highest incidence of bone fractures was seen in small dogs (37.89%), followed by mini dogs (30.43%) (Table 3). In terms of body condition score (BCS), the majority of the dogs presented with bone fractures had a body condition score of 5/9 (Table 4). According to Johnson (2013), the size of the dog would not automatically predispose the dog to bone fractures. This theory was supported by the result of this study. As seen in Table 2, bone fractures have no significant association with body weight and body condition

Received: 10-07-2023, Accepted: 06-11-2023, Published online: 08-01-2024
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score. Further, the odds of a specific weight group or body condition score having a higher or lower risk of bone fracture have no significant conclusion (Table 3, 4).

Table 4. Frequency, odds ratios (OR), and 95% confidence intervals (CI) of body condition scores of dogs with bone fracture and clinically normal dogs from 2016 to 2021 presented to the Veterinary Teaching Hospital Diliman Station – Companion Animal Clinic.

Characteristic	No. of case dogs n/N (%)	No. of clinically normal dogs n/N (%)	OR	95% CI
BCS 1/9	0	0	N/A	N/A
BCS 2/9	1/161 (0.62%)	0	N/A	N/A
BCS 3/9	7/161 (4.35%)	5/161 (3.11%)	1.42	0.44 - 4.57
BCS 4/9	21/161 (13.04%)	24/161 (14.91%)	0.86	0.46 -1.61
BCS 5/9	64/161 (39.75%)	64/161 (39.75%)	1.00	0.64 – 1.56
BCS 6/9	16/161 (9.94%)	14/161 (8.70%)	1.16	0.55 – 2.46
BCS 7/9	2/161 (1.24%)	2/161 (1.24%)	1.00	0.14 – 7.19
BCS 8/9	1/161 (0.62%)	1 (0.62%)	N/A	N/A
BCS 9/9	1/161 (0.62%)	0	N/A	N/A
Unknown	48/161 (29.81%)	51/161 (31.86%)	0.92	0.57- 1.47

n: Number of dogs in each characteristic,
N: Total number of dogs with bone fracture or clinically normal dogs,
*: Statistically significant

In this study, the mixed breed was seen to have the highest incidence of bone fracture. This is contrary to the results of other studies where it was reported that the German Shepherd Dog is the breed with the highest bone fracture incidence (Ali *et al*., 2013; Libardoni *et al*., 2016). A different result was also seen in a study in Korea where Poodles and Yorkshire terriers were found to be the most affected breed (Minar *et al*., 2013). The variation of bone fracture incidence in different breeds may be related to the difference in the preference, behavior, and lifestyles of the owners in different countries. The results of this study showed there were no significant findings in relation to the odds of a specific breed having a risk for bone fracture (Table 2 and Table 5).

Received: 10-07-2023, Accepted: 06-11-2023, Published online: 08-01-2024
Available at https://e-journal.unair.ac.id/MKH/index

Table 5. Frequency, odds ratios (OR) and 95% confidence intervals (CI) of breed of dogs with bone fracture and clinically normal dogs from 2016 to 2021 presented to the Veterinary Teaching Hospital Diliman Station – Companion Animal Clinic.

Characteristic	No. of case dogs n/N (%)	No. of clinically normal dogs n/N (%)	OR	95% CI
Beagle	4/161 (2.48%)	5/161 (3.11%)	0.79	0.21- 3.02
Belgian Malinois	2/161 (1.24%)	2/161 (1.24%)	1.00	0.14 – 7.19
Chihuahua	7/161 (4.35%)	4/161 (2.48%)	1.78	0.51 – 6.22
Chow Chow	1/161 (0.62%)	2/161 (1.24%)	0.50	0.04 -5.54
Dachshund	3/161 (1.86%)	5/161 (3.11%)	0.59	0.14 - 4.52
German Shepherd	3/161 (1.86%)	5/161 (3.11)	0.59	0.14 -2.52
Golden Retriever	3/161 (1.86%)	6/161 (3.73%)	0.49	0.12 – 2.00
Jack Russel	1/161 (0.62%)	2/161 (1.24)	0.50	0.04 – 5.54
Japanese Spitz	2/161 (1.24%)	2/161 (1.24%)	1.00	0.14 – 7.19
Labrador	6/161 (3.73%)	9/161 (5.59%)	0.65	0.23 -1.88
Lhasa apso	1/161 (0.62%)	2/161 (1.24%)	0.50	0.04 – 5.54
Maltese	1/161 (0.62%)	5/161 (3.11%)	0.20	0.02 -1.69
Mini pinscher	3/161 (1.86%)	2/161 (1.24)	1.51	0.25 -9.16
Mixed	58/161 (36.02%)	63/161 (39.13%)	0.88	0.56 -1.38
Pomeranian	17/161 (10.56%)	8/161 (4.97%)	2.26	0.95 – 5.93
Rottweiler	1/161 (0.62%)	1/161 (0.62%)	1.00	0.06 -16.13
Shih Tzu	25/161 (15.53%)	20/161 (12.42%)	1.30	0.69-2.44
Siberian Husky	2/161 (1.24%)	3/161 (1.86%)	0.66	0.11- 4.02
Toy Poodle	9/161 (5.59%)	6/161 (3.73%)	1.53	0.53 – 4.40
Yorkshire Terrier	3/161 (1.86%)	1/161 (0.62%)	3.04	0.31- 29.52

n: Number of dogs in each characteristic,
N: Total number of dogs with bone fracture or clinically normal dogs,
*: Statistically significant

Diet was found to be a significant risk factor for bone fracture (Table 2). A previous study reported that imbalances in Vitamin D, phosphorous and Calcium produce thin-walled bone which led to femoral fractures in dogs (Light *et al*., 1941). Dogs fed on purely dry commercial dog food were found to be 0.36 less likely to have a bone fracture (Table 6). This may be due to the complete dietary requirements provided in commercial dog foods. On the other hand, dogs that were fed table food are found to be 0.50 less likely to have a bone fracture. It may be possible that in this study, the dogs fed with table food are getting a sufficient amount of nutrients that are required

Received: 10-07-2023, Accepted: 06-11-2023, Published online: 08-01-2024
Available at https://e-journal.unair.ac.id/MKH/index

for good bone development. However, since the medical records only indicated "table food" as the diet of the animal, without further description, it is uncertain if indeed these dogs were receiving an incomplete or deficient diet. Further studies were needed to identify the specific table food given for better analysis of the relationship between table food and bone fractures. According to Libardoni *et al*. (2016) and Minar *et al*. (2018), bone fractures were more prevalent in dogs who live in housing that have direct access to roads. Based on Table 2, the animal's abode was found to be a significant risk factor for bone fracture. However, due to the lack of data on the patient's abode in Table 6, no conclusion can be derived from this study to support this theory.

Table 6. Frequency, odds ratios (OR), and 95% confidence intervals (CI) of diet and abode of dogs with bone fracture and clinically normal dogs from 2016 to 2021 presented to the Veterinary Teaching Hospital Diliman Station – Companion Animal Clinic.

Characteristic	No. of case dogs n/N (%)	No. of clinically normal dogs n/N (%)	OR	95% CI
Diet				
Dry dog food	43/161 (26.71%)	81/161 (50.31%)	0.36*	0.23-0.57
Wet dog food	2/161 (1.24%)	1/161 (0.62%)	0.18	0.18 – 2.44
Table food	22/161 (13.66%)	39/161 (24.22%)	0.50*	0.28-0.88
Dry + table food	16/161 (9.94%)	20/161 (12.42%)	0.78	0.39-1.56
Wet + table food	1/161 (0.62%)	1/161 (0.62%)	1.00	0.06 -16.13
Unknown	75/161 (46.58%)	18/161 (11.18%)	6.93	3.88-12.37
Abode				
Indoor dog	6/161 (3.73%)	0	N/A	N/A
Outdoor dog	1/161 (0.62%)	0	N/A	N/A
Unknown	154/161 (96.65%)	161/161 (100%)	N/A	N/A

n: Number of dogs in each characteristic,
N: Total number of dogs with bone fracture or clinically normal dogs,
*: Statistically significant

Received: 10-07-2023, Accepted: 06-11-2023, Published online: 08-01-2024
Available at https://e-journal.unair.ac.id/MKH/index

Treatment given to fracture patients varied from case to case. External coaptation was attempted in 27 cases of bone fracture. Out of 27 cases. Only 14 of the 27 cases came back for follow-up within 2 to 8 weeks with all of them showing completely healed fracture. According to Weinstein (2004), external coaptation is an effective means of repair for growing animals since it does not interfere with bone growth. Further, transverse and oblique fractures can be effectively corrected using casts and splints. Closed reduction was attempted in 3 cases to correct a fracture on the appendicular region. It is the procedure of choice for fractures of the appendicular region because it uses external fixators to stabilize the fracture (Majan *et al*., 2015). In this study, casts and splints were used to stabilize the fracture.

The most common supportive medicines that were given to patients in this study were calcium supplements and Vitamin C. These standard orthopedic supplements help in bone remodeling and mineralization which are important parts of fracture callus formation (Fischer *et al*., 2018). Non-steroidal anti-inflammatory drugs (NSAIDs) such as meloxicam and carprofen were prescribed for the relief of pain and inflammation. According to Laredo *et al*. (2004), both meloxicam and carprofen are effective in relieving signs of pain in dogs. Antibiotics and dimethyl sulfoxide (DMSO) were prescribed to patients who suffered trauma from vehicular accidents. The use of antibiotics can prevent secondary bacterial infection in patients with open injuries. The application of DMSO topically provides temporary pain relief in cases of arthritis and connective tissue injuries (Swanson, 1985).

Information regarding the patients after treatment was very limited. Out of the 161 cases of bone fracture, only 14 cases had a recorded follow-up check-up. Cage rest was recommended for 8.07% of the cases and about 23.61% of the cases have no recorded treatment or follow-up, while 19.87% of the cases were referred for treatments but the compliance of the clients was not recorded. Previous studies have not described the treatment regimen for bone fracture

CONCLUSION

In conclusion, among dogs presented with fractures, the majority of the causes were unknown followed by falls from height and vehicular trauma. The appendicular bones were mostly affected, specifically the radius and ulna are mostly affected with closed, complete, oblique types of fracture. Age was seen as a significant risk factor with no specific age group having a higher or lower odds of having a bone fracture. Dogs fed purely commercial dog food and table food are 0.36 and 0.50 times lower of having a bone fracture, respectively. Furthermore, the abode of the animal is also found to be a

Received: 10-07-2023, Accepted: 06-11-2023, Published online: 08-01-2024
Available at https://e-journal.unair.ac.id/MKH/index

significant risk factor. Given this etiology, pet owners should be educated regarding the risk factors for fractures during the presentation of pets in the veterinary facility with the aim of preventing fractures in dogs as well as early diagnosis and treatment.

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Received: 10-07-2023, Accepted: 06-11-2023, Published online: 08-01-2024
Available at https://e-journal.unair.ac.id/MKH/index