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**Research article**

Incidence and classification of bone fracture in dogs and cats: a retrospective study at a Veterinary Teaching Hospital, Khon Kaen University, Thailand (2013-2016)

Amphone Keosengthong¹, Naruepon Kampa^{2,*}, Supranee Jitpean², Suvaluk Seesupa²,
 Panisara Kunkitti³ and Somphong Hoisang⁴

¹ Faculty of Veterinary Medicine, Khon Kaen University, Khon Kaen 40002, Thailand

² Division of Surgery, Faculty of Veterinary Medicine, Khon Kaen University, Khon Kaen 40002, Thailand

³ Division of Theriogenology, Faculty of Veterinary Medicine, Khon Kaen University, Khon Kaen 40002, Thailand

⁴ Veterinary Teaching Hospital, Faculty of Veterinary Medicine, Khon Kaen University, Khon Kaen 40002, Thailand

Abstract

The incidence and classification of bone fracture in dogs and cats at a Veterinary Teaching Hospital (VTH), Khon Kaen University (KKU) was studied. A total of 1,780 from 106,286 dogs and 255 from 22,258 cats diagnosed as bone fracture cases based on the radiographs from all presented cases during 2013-2016 were reviewed. The data collection composed of breeds, genders, ages, body weight including details of bone fractures, parts of the body, affected bones, causes of fractures and types of bone fracture were collected and analyzed. The results were presented as descriptive statistics. The incidence of bone fracture in dogs and cats were 1.7% and 1.1%, respectively. Regarding to breeds in both dogs and cats, mongrel breed were the most affected at 40.6% and 66.3%, respectively. Male dogs (58.4%) were more affected than female dogs (41.6%), whereas in cats the proportion was similar in males and females at 49.6% and 50.4%, respectively. Approximately 55% and 65% of bone fractures occurred in dogs and cats that were less than one-year-old. Medium size dogs, body weight between 10 to 25 kg were the most affected (35.2%). Road traffic accidents were the highest cause of bone fractures in both dogs (79.5 %) and cats (56.3%). Pelvic limbs were the most affected bones being 85.2% in dogs and 86.5% in cats. The highest incidence of affected bones in dogs and cats was the femur at 29.6% and 35.70%, respectively.

Keywords: : Bone fracture, Canine, Feline, Thailand

*Corresponding author: Naruepon Kampa, Division of Surgery, Faculty of Veterinary Medicine, Khon Kaen University, Khon Kaen 40002, Thailand.
 E-mail: naruepon@kku.ac.th

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INTRODUCTION

Bone fracture is the medical condition in which there is a partial or complete break in the continuity of the bone. The clinical signs can be varied according to which bone is affected and may be characterized as lameness, swollen, bleeding. Incidence in epidemiology is a measure of the probability of occurrence of a given medical condition in a population within a specified period of time. Classification of bone fracture is based on individual animal information, anatomical system and may involve external risk factors (Newton and Nunamaker, 1985).

Incidence of bone fracture in dogs and cats have been reported in different regions of the world. In Thailand, classification of long bone fracture in dogs and cats was reported by Thengchaisri et al. (2006). However, the incidence of bone fracture in Thailand has never been reported officially elsewhere. A study in Nigeria by Uwagie-Ero et al. (2018), examined a total of 3,212 dogs between 2006-2016 and found that the incidence of bone fracture was 2.77% (89/3,212). In relation to bone fracture incidence to breeds in dogs from Nigeria and Libya they were mostly found in German shepherds (Ali, 2013; Eyarefe and Oyetayo, 2016). Other studies based on pelvic limb fracture in dogs, were found to be in mongrel breeds (Simon et al., 2010; Simon et al., 2011; Rhangani, 2014; Uwagie-Ero et al., 2018). In an appendicular bone fracture's study in Korea and Brazil, the Poodle breed was highest (Minar et al., 2013; Libardoni et al., 2016). In cats in Brazil, a long bone fracture's study found that 90.7% of the fractures were presented in mongrel breeds followed by Siamese at 6.4%, respectively, (Borges Cardoso et al., 2016). In relation to genders, male dogs were affected more than females (Harasen, 2003b; Simon et al., 2010; Simon et al., 2011; Minar et al., 2013; Rhangani, 2014; Vidane et al., 2014; Libardoni et al., 2016; Uwagie-Ero et al., 2018). Incidence of bone fracture relating to ages in dogs has been shown to vary between different regions of the world. Previous studies in Brazil and Korea found that bone fracture occurred in dogs less than one year old followed by 1-3 years and 3-10 years (Minar et al., 2013; Libardoni et al., 2016) whereas in USA and Nigeria it has been reported that bone fracture in dogs were high in dogs over 3 years old followed by 1-3 years and less than one year, respectively (Roush, 2014; Uwagie-Ero et al., 2018). In cats, Borges Cardoso et al. (2016) have reported that fractures occurred in less than one year old cats at 58.16%.

There are several principle causes of bone fracture in dogs and cats, such as road traffic accident, falling from heights, human abuse, animal biting, indoor trauma and unknown trauma (Ali, 2013; Minar et al., 2013; Rhangani, 2014; Libardoni et al., 2016; Uwagie-Ero et al., 2018). However, several studies had reported that the most common cause of bone fracture was road traffic accident accidents (Ali, 2013; Minar et al., 2013; Rhangani, 2014; Libardoni et al., 2016; Uwagie-Ero et al., 2018). In Korea, based on 56 small breed dogs, 43% of bone fracture cases were caused by road traffic accident followed by falling from heights at 28.5%, trauma at 16%, indoor trauma at 3.5%, slipped down at 3.5%, animal bitten at 1.2% and unknown trauma at 2% (Minar et al., 2013). In Libya, 36.2% of bone fracture in dogs were caused by car accident, followed by indoor trauma 25% and other causes. In cats, bone fracture

was mostly caused by falling from heights at 35.7% followed by car accidents (21.4%) and other causes such as human abuse, indoors trauma, unknown trauma (Ali, 2013).

A study in dogs and cats by Bennour et al. (2014) found that pelvic limb fracture was highest at 73.6% (28/38) and 86.7% (46/53), respectively. Borges Cardoso et al. (2016) reported that 79.89% of bone fracture occurred in the hind limbs and mostly occurred at the femur (50.9%) followed by tibia/fibula (29%), in radius/ulna and humerus (10.6% and 9.5%), respectively. About 2.4 million dogs and 480,000 cats have been classified as having bone fracture in USA, while most of the bone fractures in dogs occurred on the radius and ulna (36%) followed by the tibia (22%), femur (19%), skull (12%), humerus (7%), ilium (2%), vertebral (1.5%), and scapula 0.5%. In cats, fractures of the femur were predominating at the (36.5%) followed by the tibia (19%), radius/ulna (16%), skull (15%), humerus (8%), ilium (3%), spine (3%), and scapula (0.5%) (Roush, 2014). A study in Nigeria, has found that fractures occurred mostly of the femur (57.69%) followed by the tibia (10.3%), humerus (6.4%), radius/ulna (5.1%), metacarpal (3.9%), metatarsal (2.6%), skull and mandible (5.1%), and rib fracture (1.3%) (Eyarefe and Oyetayo, 2016).

The incidence and classification of bone fracture in Thailand could be either similar or different from the other regions in the world. Therefore, this information would be useful as the baseline information and could be used for veterinarian training programs in specific orthopedic topics, providing useful information for the teaching/training purposes.

MATERIALS AND METHODS

All radiographs in the computer server, Picture Archiving Communication System (PACS), at VTH from 2013 to 2016 were reviewed. Only radiographic cases diagnosed as bone fracture were used. Of 1,780 fractures cases from a total of 106,286 dogs and 225 fracture cases from a total of 22,258 cats were reviewed. The radiographs were interpreted and as the site of fracture, affected bone, site of long bone fracture and type of fracture were recorded. Records (Out Patient Department, OPD card) of each animal were reviewed. The information included breeds, genders, ages, body weight, orthopedic examination information, causes of fracture that related to bone fracture. The dogs were divided into four age groups, namely, less than one year, between 1-3 years, 3-10 years, and more than 10 years. In cats, age groups were categorized into 3 groups: age group less than one year, 1-3 years, and more than three years. In relation to size of dogs, this was categorized as less than 5 kg, as 5-10 kg, 10-25kg and above 25 kg (Minar et al., 2013; Roush, 2014; Libardoni et al., 2016). Classification of bone fracture types were followed the previous protocol (Newton and Nunamaker, 1985; Ishman and Friedland, 2004). The data was analyzed and presented as percentage by descriptive statistics.

RESULTS

The total bone fracture cases of bone fracture in dogs and cats in four years (2013-2016) were 1,780 of 106,286 and 255 of 22,258 presented cases at VTH, respectively. The average incidence of bone fracture was 1.7% in dogs and 1.1% in cats. Affected bone fracture could occur more than one site in each case. The summary of incidence bone fracture in dogs and cats by years is shown in Table 1. The distribution of bone fracture among different breeds of dogs was highest in mongrel breeds (40.6%), followed by Golden Retriever (7.6%) and the other breeds as shown in Table 2. In cats, incidence and classification of bone fracture related to breeds was mostly found in mongrel breeds (88.6%), followed by Persian (6.3%), and in other breeds (3.5%) as shown in Table 3.

Table 1 Incidence of bone fracture in dogs and cats.

| Animal | | Dogs | | | Cats | | | |
|--------|-------------|---------|---------|---------------|-------------|---------|---------|---------------|
| Year | Total cases | Fx case | Fx site | Incidence (%) | Total cases | Fx case | Fx site | Incidence (%) |
| 2013 | 24,965 | 325 | 608 | 1.3 | 3,692 | 45 | 70 | 1.2 |
| 2014 | 24,635 | 445 | 768 | 1.8 | 4,588 | 50 | 74 | 1.1 |
| 2015 | 28,233 | 415 | 704 | 1.5 | 6,828 | 54 | 84 | 0.8 |
| 2016 | 28,453 | 595 | 1,029 | 2.1 | 7,150 | 106 | 183 | 1.5 |
| Total | 106,286 | 1,780 | 3,109 | 1.7 | 22,258 | 255 | 411 | 1.1 |

Fx=fracture

When gender was examined, male dogs were affected (58.43%) more than female dogs (41.57%). In cats, the incidence of bone fracture occurred equally in males (50.39%) and females (49.61%) as shown in Figure 1. Incidence of bone fracture in dogs were found to be highest in dogs less than one year old (54.83%) followed by 3-10 years (21.97%) and the others (Figure 2). In cats, bone fractures were found predominantly in age groups less than one year (65.2%), followed by 1-3 years (24.2%) and more than 3 years (10.5%) old.

Table 2 Incidence of bone fracture related to breed in dogs.

| Dogs (Breeds) | No (N) | Percent (%) | Dogs (breeds) | No (N) | Percent (%) |
|--------------------|--------|-------------|-------------------|--------|-------------|
| Mongrel | 722 | 40.6 | Alaskan | 11 | 0.6 |
| Golden retriever | 136 | 7.6 | French bulldog | 10 | 0.6 |
| Poodle | 126 | 7.1 | Jack Russell | 9 | 0.5 |
| Pomeranian | 106 | 6.0 | Splits | 7 | 0.4 |
| Other | 94 | 5.3 | Rottweiler | 7 | 0.4 |
| Shih-Tzu | 92 | 5.2 | Yorkshire terrier | 7 | 0.4 |
| Thai ridgeback | 69 | 3.9 | Cocker spaniel | 6 | 0.3 |
| Bangkaew | 57 | 3.2 | Bulldogs | 5 | 0.3 |
| Chihuahua | 54 | 3.0 | Maltese | 4 | 0.2 |
| Siberian husky | 47 | 2.6 | Bull terrier | 4 | 0.2 |
| Labrador retriever | 47 | 2.6 | Basset hound | 3 | 0.2 |
| Pug | 40 | 2.2 | Dachshund | 2 | 0.1 |
| Beagle | 29 | 1.6 | Schnauzer | 2 | 0.1 |
| Pitbull terrier | 26 | 1.5 | American bulldog | 1 | 0.1 |
| Miniature pinscher | 25 | 1.4 | St. Bernard | 1 | 0.1 |
| German shepherd | 17 | 1.0 | Pekingese | 1 | 0.1 |
| Collie | 12 | 0.7 | Dalmatian | 1 | 0.1 |

Table 3 Incidence of bone fracture related to breed in cats.

| Breed | Number (N) | Percentages (%) |
|--------------------|------------|-----------------|
| Mongrel | 226 | 88.6 |
| Persian | 16 | 6.3 |
| Scottish fold | 4 | 1.6 |
| American shorthair | 2 | 0.8 |
| Khao manee | 2 | 0.8 |
| Munchkin | 2 | 0.8 |
| Siamese | 2 | 0.8 |
| British shorthair | 1 | 0.4 |
| Total | 255 | 100 |

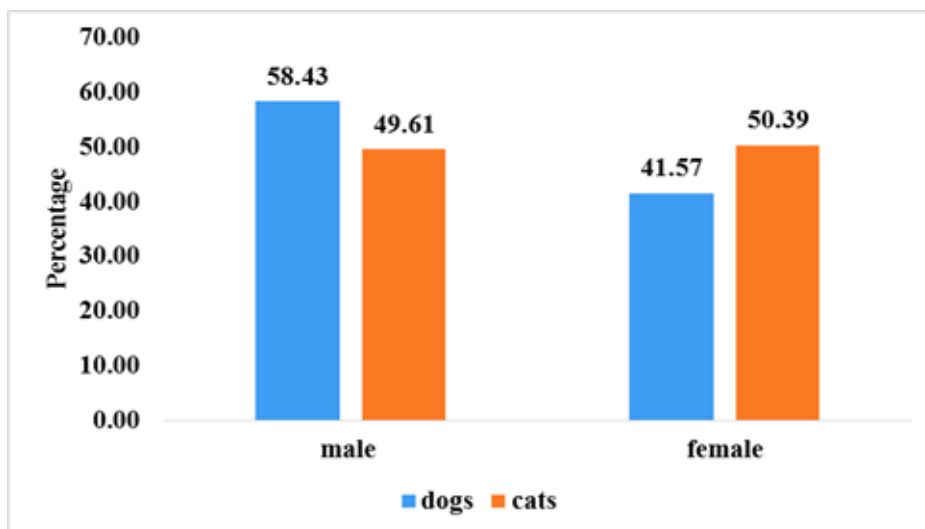


Figure 1 Incidence of bone fracture related to genders in both dogs and cats.

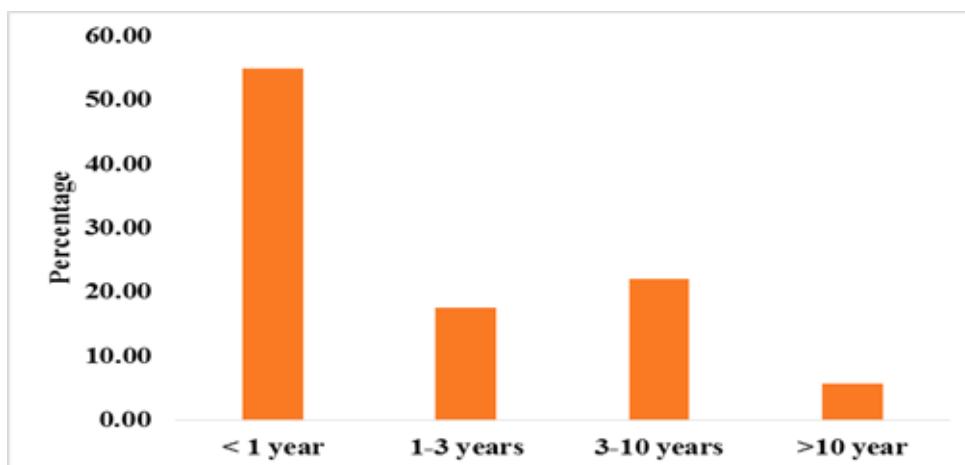


Figure 2 Incidence of bone fracture in dog related to ages.

Incidence of bone fracture in dogs in relation to body weight, was found mostly in dogs of weight 10-25 kg (35.2%), followed by dogs 5-10 kg (28.9 %) and other remainder (Figure 3). Regarding to the causes of bone fracture in dogs, most of fracture was caused by road traffic accident (79.4%), followed by unknown trauma (9.9%) and other causes as shown in Figure 4. This was similar for cats, where bone fracture was mostly caused by road traffic accidents (56.3%), followed by unknown trauma (23%), other causes (Figure 4).

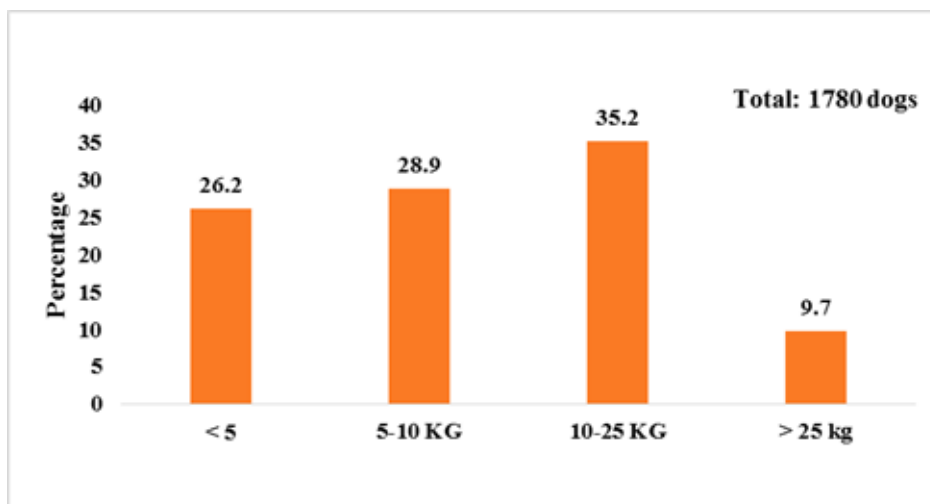


Figure 3 Incidence of bone fracture in dogs related to body weight.

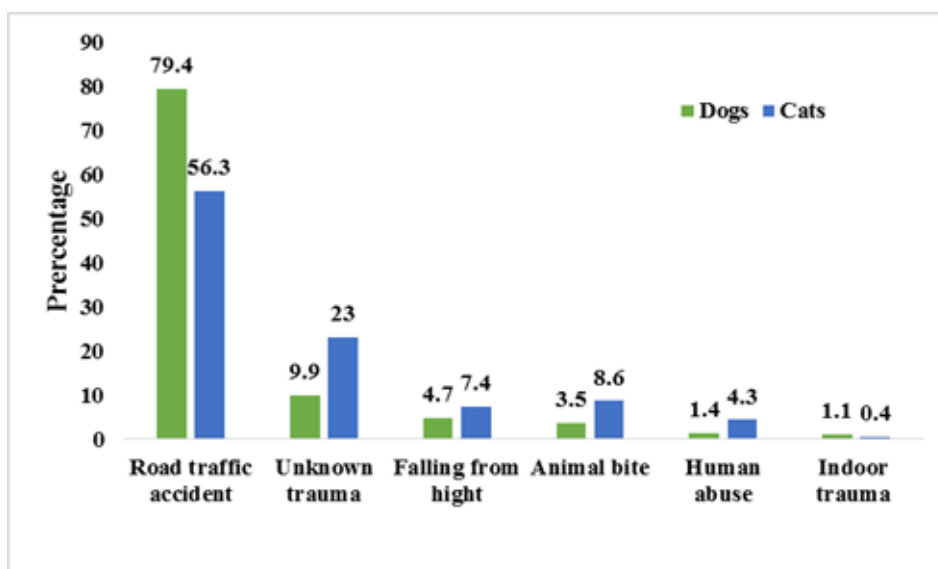


Figure 4 Incidence of bone fracture in dogs and cats related to causes

Of 3,110 and 409 sites (body parts) affected bone fracture in dogs and cats in the present study, they were categorized as: skull/mandible, vertebrae bones, forelimb/scapular bones, and pelvic limb bones. The most affected bone fractures in dogs was in pelvic limbs (85.2%), followed by forelimbs (9.6%) and other body parts (Figure 5). In cats, fractures was found predominantly in pelvic limbs (86.3%), followed by forelimbs (5.9%) and other body parts (Figure 5).

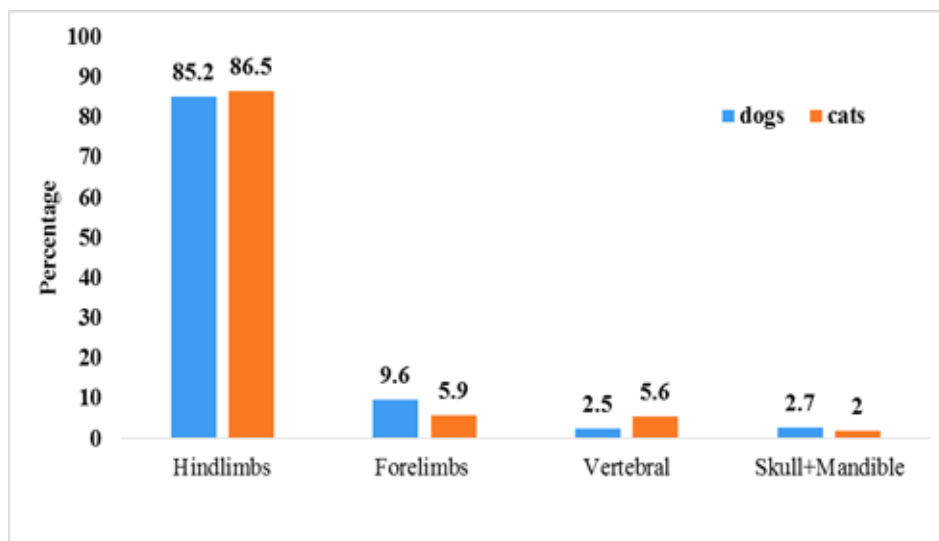


Figure 5 Classification of bone fracture in dogs and cats based on the body parts.

In relation to the number of fracture sites in each case, multiple fractures were found in 44.1% of dogs and 37.8% of cats. Among 3,110 sites of bone fracture in dogs, the most affected bone fracture was the femur (29.6%) followed by sacroiliac joint (11.9%) and others as shown in [Table 4](#). This was similar in cats, where bone fractures were found of the femur 35.7% followed by the sacroiliac joint (15.4%), tibia and fibula (11.5%) and other affected ([Table 4](#)). Regarding the type of bone fracture, the most common type of fracture was transverse fractures (68%) followed by comminuted fractures (12.2%). Transverse fractures were found in 59.2% of cats, followed by comminuted fractures (17.8%). Other types of bone fracture in both dogs and cats are shown in [Table 5](#).

Table 4 Classification of bone fracture on affected bone.

| Affected bone (site) | Dogs (N) | Percent (%) | Cats (N) | Percent (%) |
|----------------------|----------|-------------|----------|-------------|
| Femur | 920 | 29.6 | 146 | 35.7 |
| Sacroiliac joint | 371 | 11.9 | 63 | 15.4 |
| Tibia/Fibula | 349 | 11.2 | 47 | 11.5 |
| Ilium | 303 | 9.7 | 26 | 6.4 |
| Pubis | 302 | 9.7 | 28 | 6.8 |
| Ischium | 259 | 8.3 | 20 | 4.9 |
| Radius/ulna | 181 | 5.8 | 12 | 2.9 |
| Acetabulum | 128 | 4.1 | 17 | 4.2 |
| Humerus | 108 | 3.5 | 10 | 2.4 |
| Mandible | 69 | 2.2 | 7 | 1.7 |
| Vertebrae | 55 | 1.8 | 14 | 3.4 |
| Tail | 24 | 0.8 | 8 | 2 |
| Metatarsus | 15 | 0.5 | 6 | 1.5 |
| Scapular | 2 | 0.06 | 2 | 0.5 |
| Metacarpus | 8 | 0.3 | 2 | 0.5 |
| Maxilla | 8 | 0.3 | 1 | 0.2 |
| Skull | 8 | 0.3 | 0 | 0 |
| Total | 3,110 | 100 | 409 | 100 |

N=site of bone fracture

Table 5 Classification of bone fracture in dogs and cats on type.

| Type of fracture | Dogs (cases) | Percentage (%) | Cats (cases) | Percentage (%) |
|------------------|--------------|----------------|--------------|----------------|
| Transverse | 2,114 | 68.0 | 242 | 59.2 |
| Comminuted | 379 | 12.2 | 73 | 17.8 |
| Oblique | 293 | 9.4 | 32 | 7.8 |
| Physeal | 107 | 3.4 | 17 | 4.1 |
| Spiral | 84 | 2.7 | 4 | 1.0 |
| Fissure | 69 | 2.2 | 21 | 5.1 |
| Condylar | 32 | 1.0 | 8 | 2.0 |
| Compression | 16 | 0.5 | 6 | 1.5 |
| Avulsion | 9 | 0.3 | 0 | 0.0 |
| Green stick | 8 | 0.3 | 6 | 1.5 |
| Total | 3,110 | 100 | 409 | 100 |

DISCUSSION

The overall incidence of bone fracture cases at VTH, during 2013-2016 in dogs was 1.7% (1,780/106,286) and in each year ranged between 1.3-2.1%. The incidence in this study was slightly lower than the previous study by [Uwagie-Ero et al. \(2018\)](#) who reported a 2.77% level. Another study by [Eyarefe and Oyetayo \(2016\)](#), found the incidence to be 12.6% from orthopedic cases. The high incidence of bone fracture has been reported to be 79.6% appendicular fractures when orthopedics cases were examined ([Libardoni et al., 2016](#)). In cats, the incidence of bone fractures in our study was 1.1% (255/22,258) during the four years ranging from 0.8%-1.5%. This is lower than 23% previously reported in studies from Libya from referral bone fracture cases without known total number ([Ali, 2013](#)). The lower incidence in our study could be due to the different number of presented cases at the animal hospital. At the VTH-KKU, the number of cases used to calculate the overall incidence was higher than previous studies. This could be due to the VTH serving not only referral cases, but also general cases with/without appointment.

We found that 40.6% of mongrel breed dogs presented at the VTH-KKU were bone fracture cases. Our result was similar to the previous study of [Uwagie-Ero et al. \(2018\)](#) who found that a similar level of mongrel breed dogs presented with bone fractures. Some previous studies have reported that German shepherds was the most affected breed ([Ali, 2013](#); [Rhangani, 2014](#); [Libardoni et al., 2016](#)). Results from this study were different to the study in Korea where small animal breeds such as Poodles and Yorkshire terriers were found to be the highest bone fracture cases ([Minar et al., 2013](#)). The different breed The variation of incidence of bone fractures in different breeds of dogs may be related to owner living regions/countries which may differ in behavior/life styles in the different countries. A previous report by [Borges et al. \(2016\)](#) found that the highest incidence of bone fractures in cats was in mongrel breeds (90.07%). This was similar to our study in Thailand where bone fracture was occurred predominantly in cats of mongrel breed (88.6%). The highest incidence occurred in cats of mongrel breed could be due to the fact that the majority of cats in Thailand are of mix breed.

In our study, male dogs (58.4%) were affected more than female (41.6%) which similar to previous reports ([Ali, 2013](#); [Rhangani, 2014](#); [Uwagie-Ero et al., 2018](#)), but with differing levels. Our results may be related to the male dogs' behavior which more dominant, territorial, and easily distracted than female dogs and hence may increases the risk of fractures from the road traffic accidents. However, further study is required to determine whether there is a correlation. However, in cats, the incidence of fracture was almost the same between males and females.

In relation to age, bone fracture was mostly occurred in dogs and cats of less than one-year-old. This finding was similar to the previous studies ([Ali, 2013](#); [Minar et al., 2013](#); [Uwagie-Ero et al., 2018](#)). One previous study reported that 58.16% of fractures occurred in dogs less than one-year-old ([Ali, 2013](#)). A study in small breed dogs, the incidence of bone fracture was about 45% of dogs less than one-year-old ([Minar et al., 2013](#)), which also trended to have a high risk of bone fracture when compared to older dogs which may due to their behavior and their previous experiences.

In our study, we found that the incidence of bone fracture in dogs was high in dogs of weight 10-25 kgs (35.2%), followed by dogs 5-10 kgs (28.9%), < 5 kgs (26.2%), and > 25 kgs (9.7%). A study by Libardoni et al. (2016) reported that bone fracture was also high in dogs weighing 5 kgs (42.7%) followed by dogs weighing 5-10 kgs (23.9%), 10- 15 kgs (16.7%), < 5 kgs (14.3%), and > 25 kgs (2.4%). The high incidence of bone fractures in this study were of dogs weighing 10-25 kgs. This finding was probably related to body weight of mongrel breed's dogs that was the group of dogs that mostly presented of bone fracture cases. In contrast, the incidence of bone fracture compared to the size/weight of dogs was different in Korea. Most of people living in Korea may prefer to have small breed dogs, which could be related to their living conditions and life style where people stay in apartments in cities (Minar et al., 2013). In the USA, small breed dogs were also found to have as the highest incidence (Roush, 2014) of bone fractures (50.4%).

We found that the causes of bone fractures in dogs and cats, was mostly due to road traffic accidents, (79.4% and 56.3%, respectively), which is higher than the previous study by Uwagie-Ero et al. (2018) who reported that 66.3% of fractures were caused by vehicles, and Borges et al. (2016) have reported a 42.5% level. Similar to the observation of the previous study in Korea (Minar et al., 2013), main cause of bone fracture was caused by car accident at 43%. In Thailand, the cause of bone fracture by road traffic accident was high as expected. This finding may also relate to the higher incidence of bone fractures found in male dogs which may increase the risk of fractures due to their behavior as well.

The sites of affected bone fracture in both in dogs and cats mostly occurred in the pelvic limbs (85.2% and 86.5%, respectively). Previous studies reported that the long bones were the skeletal part which was mostly affected in dogs and cats (Harasen, 2003a; Thengchaisri et al., 2006; Ali, 2013; Rhangani, 2014). Our results were similar to previous reports that bone fracture occurred in appendicular bone at 86.7% in dogs and 7.4% in cats (Bennour et al., 2014). The trauma affecting the bone most likely occurred in the caudal part of animal such as pelvic limbs. The animals may try to avoid being hit by vehicles and the hind limbs become the trauma site. (Harasen, 2003a). Our results from Thailand are similar to other studies from Korea, USA and Nigeria (Minar et al., 2013; Roush, 2014; Eyarefe and Oyetayo, 2016; Uwagie-Ero et al., 2018).

For instance, long bone fractures or appendicular bone fractures such as of the femur was found in 51.5% of dogs in India (Simon et al, 2010), 30% in Kenya (Rhangani, 2014), 23.5% in Philippines (Libardoni et al., 2016) 25% in Korea (Minar et al., 2013), 50.4% in Egypt 50.6% (Elzomor et al., 2014) and 50.4% in Thailand (Thengchaisri et al., 2006). In our study, 29.6% and 35.7% of long bone fractures in dogs and cats, respectively, which was similar to previous studies (Bennour et al., 2014; Roush, 2014; Eyarefe and Oyetayo, 2016; Uwagie-Ero et al., 2018). Most (79.9%) of the long bone fractures in cats occurred in hind limbs, namely the femur (63.6%), followed by tibia and fibula (36.4%), whereas in forelimbs, 58.2% of bone fractures were the radius/ulna (and 42.77% the humerus (Borges Cardoso et al., 2016). The high incidence of femur fracture may be due to the length of the femur which is two quarters of the hind limbs therefore having greater and easier expose the impact force. It has been reported that bending forces are major components that lead to fractures (Newton and Nunamaker, 1985).

Pelvic fracture was mostly presented in multiple fractures in both dogs and cats associated with high energy or force. In our study, we found that the type of fracture in both dogs and cats was highest in transverse (68% and 59.2%, respectively), followed by comminuted (12.2% and 17.8%, respectively) fractures, which is consistent with results of previous studies (Simon et al., 2010; Ali, 2013; Rhangani, 2014). Type of fracture in long bones can vary in different cases such as, transverse, oblique, spiral, fissure, and greenstick. However, we found that the transverse fracture type was the most common found in both dogs and cats which also depends on onset of force on the bone.

CONCLUSION

In this study, the overall incidence of bone fracture in dogs was slightly higher than cats, and mongrel breeds were affected more than other breeds. This finding was similar in cats. Regarding genders, male dogs were affected more than female dogs. In contrast for cats, the incidence was equal between males and females. In both dogs and cats, the incidence of bone fractures was found mostly in age group less than one year. When body weight of dogs is compared, the highest incidence was found predominately in dogs of medium body weight of 10–25 kgs followed by dogs of 5-10 kgs in weight.

Regarding to the causes of bone fracture, our results of the causes of bone fractures were similar to previous reports where the main cause of bone fractures in dogs and cats was found to be due to road traffic accidents. Pelvic limbs, especially the long bones such as the femur, was the most affected bone in dogs and cats. The most common type of fracture in both dogs and cats was a transverse followed by comminuted type, respectively.

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