B-4876
[1-5]

CASE STUDY Indian Journal of Animal Research

Incidence, Occurrence and Classification of Long Bone Fractures in Dogs: A Retrospective Study

P. Ravi Kumar, V. Devi Prasad, M. Sreenu, G. Venkata Naidu, N. Kranthi Bhushan Raju

10.18805/IJAR.B-4876

ABSTRACT

Background: Long bone fracture in small animals has become a problem of concern in urban areas as well as rural areas because of road accidents. Canine long bone fracture cases presented at surgery wards of the hospital during 2017-20 were analysed for determining their incidence, occurrence and classification of fractures.

Methods: The present study was conducted on long bone fractures in dogs presented to the surgery ward of SVVU Super Speciality Veterinary Hospital, Visakhapatnam from 2017 to 2020. Detailed history and signalment was followed by detailed physical examination to determine the site of fracture, extent of soft tissue swelling and presence of open wounds. Radiographic evaluation was done to localize the seat of fracture, to identify the type of fracture and to find out relation between the fracture fragments

Result: Of all the cases of dog patients presented to the surgery ward 2.02% were diagnosed to have fracture of different bones. Fracture of long bones (326), comprised 1.50% of total cases and 74.42% of fractures cases. The highest incidence was recorded in mongrel dogs and the most common affected bone was tibia fibula. Fall from height was reported as an etiological factor in majority of the cases and Juvenile group of animals was found more affected.

Key words: Canine, Fracture, Long bone, X-ray.

INTRODUCTION

Canine long bone facture is a common orthopaedic problem in urban areas, however in the recent past, the increased incidence has been reported from rural areas too. High occurrence of fractures in dogs is reported due to road traffic accidents or fall form a height (Aithal *et al*., 1999; Harasen, 2003; Beale, 2004). Fractures are frequently seen in young or growing animals (Harasen, 2001) attributed also to metabolic and nutritional disorders (Rosol and Capen, 1997) or to their enthusiastic behaviour (Bennour *et al*., 2014). Conduct of retrospective and prospective study is highly essential to determine the most prevalent diseases in a particular geographical area to chalk out the future strategy for their enhancement (Chaves, 2014). As the fractures are becoming the problem of concern in canines a need was felt to conduct a prospective study on prevalence of fractures at this geographical area. Several reports are available highlighting the incidence and prevalence of fractures in small animals (Shiju *et al*., 2010; and 2011; Ali, 2013, Jain *et al*., 2018). By knowing the frequency and prevalant type of fractures in the domestic animals, the veterinarians involved in orthopaedics could focus their attention for better fracture fixation techniques, thus increasing the efficiency in the treatment of fractures (Vidane *et al*., 2014). The present study is an endeavor in this direction to make a beginning for better and economical management of fractures in canines.

MATERIALS AND METHODS

The present study was conducted on clinical cases of dogs presented to SVVU Super Speciality Veterinary Hospital, Visakhapatnam from 2017 to 2020 with the symptoms of non-weight bearing lameness. Detailed history and signalment; including breed, sex, etiology, limb involved, side involved and time since injury were collected from the owner. The general condition of the animal and other associated injuries if any were noted. Detailed physical examination was carried to determine the site of fracture, extent of soft tissue swelling and presence of open wounds. Radiographic evaluation was done to localize the seat of fracture, to identify the type of fracture and to find out relation between the fracture fragments. Non-cooperative animals were sedated with intramuscular injection of Butorphanol tartrate @ 0.2 mg/Kg body weight, Acepromazine @ 0.05 mg/kg body weight and Glycopyrolate @ 0.01 mg/Kg body weight before radiography. Both cranio-caudal and medio-lateral views were taken to evaluate the type of fracture. The data collected was analyzed and represented graphically for effective comparison.

Department of Veterinary Surgery and Radiology, Super Speciality Veterinary Hospital, Sri Venkateswara Veterinary University, Visakhapatnam-530 002, Andhra Pradesh, India.

Corresponding Author: P. Ravi Kumar, Department of Veterinary Surgery and Radiology, Super Speciality Veterinary Hospital, Sri Venkateswara Veterinary University, Visakhapatnam-530 002, Andhra Pradesh, India. Email: ravikumarpallitvm1018@gmail.com

How to cite this article: Kumar, P.R., Prasad, V.D., Sreenu, M., Naidu, G.V. and Raju, N.K.B. (2022). Incidence, Occurrence and Classification of Long Bone Fractures in Dogs: A Retrospective Study. Indian Journal of Animal Research. DOI: 10.18805/IJAR.B-4876.

Submitted: 04-02-2022 **Accepted:** 02-09-2022 **Online:** 15-09-2022

RESULTS AND DISCUSSION

Incidence of long bone fractures in dogs

A total of 21,719 clinical cases of dogs were presented to the surgery ward of SVVU Super Speciality Veterinary Hospital, Visakhapatnam from February 2017 to 2020. Of these 438 (2.02%) cases were diagnosed to have fracture of different bones and among them, 326 had fracture of long bones, comprising 1.50% of total cases and 74.42% of fractures cases presented.

Breed wise distribution

Long bone fractures were recorded in sixteen different breeds (Table 1). The highest incidence was recorded in Mongrel/ non-descriptive dogs (n=129, 39.57%) followed by Pomeranian (n=74, 22.70%), mixed breed (n=37, 11.35%), Labrador retriever (n=19, 5.83%), German Shepherd (n=11, 3.37%), Golden retriever (n=9, 2.76%) and 2.15% (n=7) each in Dobermann pinscher, Dachshund, Lhasa Apso and least incidence in Tibetan mastiff (n=1, 0.31%).

Table 1: Breeds wise distribution of long bone fractures in dogs.

Name of the breed	No of cases	Percentage (%)
Mongrel/Non-decriptive	129	39.57
Pomeranian	74	22.70
Mixed	37	11.35
Labrador retriever	19	5.83
German shepherd	11	3.37
Golden retriever	9	2.76
Dachshund	7	2.15
Dobermann pinscher	7	2.15
Lhasa apso	7	2.15
Rottweiler	6	1.84
Beagle	5	1.53
Pug	5	1.53
Cocker spaniel	4	1.23
Great dane	3	0.92
Pit bull	2	0.61
Tibetan mastiff	1	0.31

*n=326.

Age wise distribution

Highest incidence was observed in the dogs of juvenile age group (n=129, 39.57) followed by mature adult (n=71, 21.78%), young adult (n=68, 20.86%) and geriatric dogs (58, 17.79%).

Sex wise distribution

Higher incidence was recorded in males (n=184, 56.44%) than that in females (n-142, 43.44%).

Limb wise distribution

Highest incidence was noticed in left hind limb (n=126, 38.41%) followed by right hind limb (n=87, 26.52%), right fore limb (n=63, 19.21%) and left fore limb (n=52, 15.85%). In two dogs bilateral limb fractures were recorded. In the present study incidence of fracture was higher in hind limbs (n=213) when compared to that in fore limbs (n=115).

Bone- wise distribution

Highest incidence of fractures was recorded in tibia and fibula (n=126, 38.07%) followed by radius and ulna (n=97, 29.32%), femur (n=89, 26.89%) and humerus (n=19, 5.74%).

Distribution of long one fractures based on etiological factors

Fall from a height (n=141, 43.25%) was recorded as most common etiological factor responsible for long bone fractures followed by automobile accidents (n=118, 36.20%), unknown etiology (n=31, 9.51%), trauma by inanimate objects in the surroundings (n=27, 8.28%), dog bite (n=7, 2.15%) and pig bite (n=2, 0.61%).

Classification of fractures based on radiographic signs

All the dogs with non-weight bearing lameness were subjected to radiography to identify the location and type of fracture. Forty eight out of 326 dogs needed sedation for this procedure. Based on these radiographic findings, the fractures were categorized as shown in the Table 2. Out of all type of fractures, complete diaphyseal long oblique fractures are reported more in humerus bone (n=6), complete diaphyseal transverse fractures are reported more in radius ulna bone (n=56), complete diaphyseal long oblique

Table 2: Distribution of long bone fractures in dogs based on radiographic features.

Type of fracture	Humerus	Radius ulna	Femur	Tibia fibula	Total	Percentage
Incomplete fractures	2	2	4	8	16	4.83
Complete diaphyseal short oblique fracture	4	35	16	59	114	34.44
Complete diaphyseal long oblique fracture	6	0	23	14	43	12.99
Complete diaphyseal spiral fracture	2	0	12	9	23	6.95
Complete diaphyseal transverse fracture	3	56	9	21	89	26.89
comminuted fracture	1	3	7	6	17	5.14
Avulsion fracture	0	0	0	5	5	1.51
segmental fracture	0	0	2	3	5	1.51
Salter Harris fractures	1	1	16	1	19	5.74
Total	19	97	89	126	331	100

*n=326, in five animals fracture of two bones was observe.

fractures are reported more in femur bone (n=23) and complete diaphyseal short oblique fractures are reported more in tibia fibula bone (n=59). The percentage of complete short oblique diaphyseal fractures was found to be high among all the cases where as avulsion and segmental fractures found to be low. Avulsion fractures were noticed only in tibia fibula bone (n=5). Salter Harris fracture were noticed more in the femur bone (n=16) when compared to other bones in the present study.

During this study an overall incidence of fractures in dogs was recorded 2.1% with long bone fractures comprising 74.42% of all fractures cases. These obervations fall in line with those of Patil *et al*. (2018) who also reported 2.48% overall incidence of long bone fractures in canines. However, higher overall incidence of fractures 7.33% (Kushwaha *et al*. (2011) and 17.8% Ali (2013) have also been reported.

In the present study, the long bone fractures were recorded in sixteen dog breeds among which the prevalence was highest in mongrel/non-decriptive and the lowest in Tibetan Mastiff. Similar to the present study, the higher incidence of fractures in non-descriptive breed was also reported by Dvorak *et al*. (2000), Rani *et al*. (2007), Simon *et al*. (2011), Manjunatha and Ranganath (2012), Patil *et al*. (2018) and Priyanka *et al*. (2019). Highest incidence was reported in other breeds too like Spitz (Aithal *et al*., 2004, Kumar *et al*., 2007 and Kushwaha *et al*., 2011), Mixed breed (Libardoni *et al*., 2016), German Shepherd (Balagopalan *et al*., 1995 and Jani *et al*., 2014), Labrador retriever (Priyanka *et al*., 2019) and Yorkshire terrier (Minar *et al*., 2013). Highest prevalence recorded in non-descriptive breeds could be attributed to their increased geographical distribution (Simon *et al*. (2011), Manjunatha and Ranganath, (2012) and Gill *et al*. (2018).

Highest incidence of long bone fractures was recorded in the dogs of Juvenile group and lowest incidence in geriatric group. Our findings are in accordance with those of Phillips (1979), Balagopalan *et al*. (1995), Aithal *et al*. (2004), Raghunath *et al*. (2007), Rani *et al*. (2007), Simon *et al*. (2010; 2011), Kushwaha *et al*. (2011) and Minar *et al*. (2013), who also reported the highest incidence of long bone fractures in the dogs aged less than one year. The higher susceptibility of young dogs to the fractures could be attributed to their soft, low density and fragile bones that are in the phase of osteogenesis and being likely to get injured even by a minor trauma (Shapiro, 2008 and Minar *et al*., 2013). Moreover the inability of the young dogs to avoid trauma make them prone fractures (Vidane *et al*. 2014).

Finding of the present study male dogs appeared more susceptible for the long bone fractures than the female dogs is in concomitance with those of other researchers Alcantara and Stead (1975), Phillips (1979), Balagopalan *et al*. (1995), Aithal *et al*. (1999), Dvorak *et al*. (2000), Fazili *et al*. (2005), Kumar *et al*. (2007), Simon *et al*. (2011) , Jani *et al*. (2014), Libardoni *et al*. (2016), Patil *et al*. (2018) and Priyanka *et al*. (2019). Increased male susceptibility to long bone frcatures might be due to their increased metabolic activity than females (Kumar *et al*., 2007 and Aithal *et al*., 1999), aggressive behaviour (Fazili *et al*., 2005) and wandering nature (Raouf *et al*., 2017 and Libardoni *et al*., 2016). And more population of male dogs (Patil *et al*. 2018) as the people prefer to rear male dogs as companion animals compared to female dogs Contrarily Altunatmaz *et al*. (2012) reported higher incidence of fractures in female dogs without stating any reason.

Hind limbs appeared more susceptible as compared to fore limbs; and left limbs appeared more susceptible when compared to right limbs. These observations are in total consonance with those of Balagopalan *et al*., (1995), Rhangani, (2014) and Bennour *et al*., (2014), who reported higher incidence of fractures in hind limbs and with those of Alcantara and Stead, (1975), Aithal *et al*., (2004) and Raghunath *et al*., (2007) who also reported that left sided limbs were more susceptible to fractures as compared to right. Singh *et al*. (1983) attributed this more incidence of fractures in hind limbs to slower reaction of dogs at their hind limbs during an effort to flee away from the impending trauma and exposing the hind quarters to trauma. Harasen (2003) stated that, trauma to the caudal half of the animals was less likely to produce life threatening injury and such type of animals were more frequently presented to the hospitals for treatment. Contrararily (Rani *et al*., 2007) recorded highest occurance of fractures in right side limbs.

Tibia-fibula was observed as the most affected bone followed by radius ulna, femur and humerus in the present study. The findings are in contrast with those of Maala and Celo (1975), Philips (1979), Balagopalan *et al*. (1995), Harasen (2003), Ozsoy (2004), Raghunath *et al*. (2007), Simon *et al*. (2010), Kushwaha *et al*. (2011), Altunatmaz *et al*. (2012), Vidane *et al*. (2014) and Patil *et al*. (2018) who reported the highest incidence of fractures in femur bone. Dvorak *et al*. (2000) reported the higher incidence of fractures in radius ulna. Weight bearing stress, in addition to normal anatomical position with geometric variation in the length of bone make the femur more vulnerable to fractures (Markel *et al*. 1994).

In the present study, the common etiological factor responsible for long bone fractures reported was fall from a height followed by automobile accidents. The findings were in accordance with those of Aithal *et al*. (2004), Kushwaha *et al*. (2011) and Raouf *et al*. (2017). Several researchers like Alcantara and Stead (1975), Phillips (1979), Ozsoy (2004), Rani *et al*. (2007), Altunatmaz *et al*. (2012), Ali (2013), Libardoni *et al*. (2016) and Priyanka *et al*. (2019) reported Automobile accidents/traffic accidents as a principal cause of long bone fractures in dogs. However Rhangani (2014) reported, unknown trauma as a principal cause of fractures in their study. Alcantara and Stead (1975), Rhangani (2014) and Libardoni *et al*. (2016) also reported animal bites as one of the causes for fractures in dogs similar to our study.

Non-weight bearing lameness on the affected limb, abnormal angulation of limb at the site of fracture, swelling at the site of fracture, crepitation at site of fracture and pain

on palpation were the common symptoms noticed in the present study as reported by Kumar *et al*. (2007), Bennour *et al*. (2014), Madhu *et al*. (2014), Patil *et al*. (2017) and Chaurasia *et al*. (2019) in the animals suffering with fractures.

Complete diaphyseal short oblique fracture was the commonest type of fracture noticed in majority cases followed by complete diaphyseal transverse fracture and complete diaphyseal long oblique fracture. The present findings differ with the observations of Shiju *et al*., (2010; and 2011); Ali, (2013), Jain *et al*., (2016) who observed more transverse fractures followed by oblique fractures. Higher incidence of transverse and oblique fractures in the present study might be due to predominance of bending forces at the site of fracture. Similar opinion was also made by Smith, (1985). In the present study, avulsion fracture was noticed only in tibia which could be due to incomplete fusion of tibial tuberosity to the rest of bone in young animals. Similar opinion was also made by Shiju *et al*., (2010).

CONCLUSION

The results of present study provide preliminary information regarding the incidence and occurrence of long bone fractures in dogs in and around Visakhapatnam city. Higher incidence was observed in Mongrel, Juvenile, male dogs with a frequently injured tibia-fibula bone. Fall from a height was the common etiological factor in most of the dogs presented. Complete diaphyseal short oblique fracture was the type of fracture noticed in majority of the animals. Further epidemiological studies are needed to widen the geographical range and to assess the predisposing factors associated with this disease.

ACKNOWLEDGEMENT

The authors thank the Sri Venkateswara Veterinary University, Tirupati for providing the all the facilities required for this study and the authors also thank all the technicians and other supporting staff associated with this study.

Conflict of interest: None.

REFERENCES

Aithal, H.P., Singh, G.R. and Bisht, G.S. (1999). Fractures in dog: A survey of 402 cases. Indian Journal of Veterinary Surgery. 20: 15-21

Aithal, H.P., Kinjavdekar, P., Amarpal, Singh, G.R., Pawde, A.M., Kumar, N. and Setia, H.C. (2004). Management of supracondylar femoral fracture by modified single pin fixation or cross intramedullary pin fixation: A comparative study in 74 clincal cases. Indian Journal of Veterinary Surgery. 25(2): 122-142.

Alcantara, P.J. and Stead, A.C. (1975). Fractures of the distal femur in the dog and cat. Journal of Small Animal Practice. 16: 649-59.

Ali, L.B. (2013). Incidence, Occurrence, Classification and Outcome of Small Animal Fractures: A Retrospective Study. In Proceedings of World Academy of Science, Engineering and Technology. 75: 628.

Altunatmaz, K., Ozsoy, S., Mutlu, Z., Devecioglu, Y. and Guzel, O. (2012). Use of intramedullary fully threaded pins in the fixation of feline and canine humeral, femoral and tibial fractures. Veterinary Comparative Orthopaedic and Traumatology. 25: 321-325.

Balagopalan, T.P., Devanand, C.B., Rajankutty, K., Amma, T.S., Nayar, S.R., Varkey, C.A., Jalaluddin, A.M., Nayar, K.N.M. and George, P.O. (1995). Fracture in dogs: A review of 208 cases. Indian journal of veterinary surgery. 16(1): 41-43.

Beale, B. (2004). Orthopedic clinical techniques femur fracture repair. Clinical Techniques in Small Animal Practice. 19: 134-150.

Bennour, E.M., Abushhiwa, M.A., Ali, L.B., Sawesi, O.K., Marzok, M.A., Abuargob, O.M., Tmumen, S.K., Abdelhadi, J.A., Abushima, M.M., Benothman, M.E., Said, E.M. and El-Khodery, S.A. (2014). A retrospective study on appendicular fractures in dogs and cats in Tripoli- Libya. Journal of Veterinary Advances. 4(3): 425-431.

Chaurasia, A., Jawre, S., Singh, R., Shahi, A., Pathak, R., Das, B. and Verma, N.K. (2019). Evaluation of haemato-biochemical parameters using different biomaterials in fracture healing of dogs. International Journal of Current Microbial and Applied Sciences. 8(05): 2265-2271.

Chaves, R.O. (2014). Neurological diseases in dogs examined at the Veterinary Teaching Hospital of the Federal University of Santa Maria, RS: 1.184 cases (2006-2013). Pesquisa Veterinária Brasileira. 34(10): 996-1001.

Dvorak, M., Necas, A. and Zatlouukal, J. (2000). Complications of long bone fracture healing in dogs Functional and radiological criteria for their assessment. Acta Veterinaria Brno. 69: 107-114.

Fazili, M.R., Chawla, S.K., Yadav, K., Tayal, R. and Behl, S.M. (2005). Long bone fractures in dogs: A Preliminary Note. Haryana Vet, 44: pp 8.

Gill, K.K., Kumar, A., Sangwan, V., Anand, A., Mahajan, S.K and Mohindroo, J. (2018). Comparative functional outcome of supracondylar femoral fracture stabilized with cross and end threaded intramedullary pinning in dogs. Indian Journal of Animal Sciences. 88(2): 161-169.

Harasen, G. (2001). Fractures involving the distal extremity of the femur Part1. The Immature patient. Canadian Veterinary Journal. 42: 949-950.

Harasen, G. (2003). Common long bone fractures in small animal practice part 1. Canadian Veterinary Journal. 44: 333-334.

Jani, S.M.Y., Kushwaha, R.B., Gupta, A.K., Malik, K. and Soodan, J.S. (2014). Occurrence of fractures in dogs: A retrospective study of five years. Indian Journal of Veterinary Surgery. 35: 73-74.

Jain, R., Parihar, A.S., Kamble, S., Parihar, Y.S. and Ganguly, S. (2016). Multiple Fractures in Tibia Bone of Dog: A Case Study. International Journal of Contemporary Microbiology. 2(1): 82-83.

Kumar, K., Mogha, I.V., Aithal, H.P., Kinjavdekar, P., Amarapal, Singh, G.R., Pawde, A. M. and Kushwaha, R.B. (2007). Occurrence and pattern of long bone fractures in growing dogs with normal and osteopenic bones. Journal of Veterinary Medical Association. 54: 484-490.

Kushwaha, R.B., Gupta, A.K., Bhadwal, M.S., Kumar, S. and Tripathi, A.K. (2011). Incidence of fractures and their management in animals: A clinical study of 77 cases. Indian Journal of Veterinary Surgery. 32: 54-56.

Libardoni, R.N., Serafini, G.M.C., Oliveira, C., Schimites, P.I., Chaves, R.O., Feranti, J. P.S., Costa, C.A.S., Amaral, A.S., Raiser, A.G. and Soares, A. (2016). Appendicular fractures of traumatic etiology in dogs 955 cases (2004-2013). Ciencia Rural. 46(3): 542-546.

Maala, C.P. and Celo, E.M. (1975). A study on the anatomical locations, incidence and causes of fractures in dogs. Philippine Journal of Veterinary Medicine. 14: 137-143.

Madhu, D.N., Ahmad, R.A., Sivanarayanan, T.B., Kumar, R., Dubey, P., Aithal, H.P., Amarpal and Kinjavdekar, P. (2014). Surgical management of supracondylar femur fracture in dogs. Indian Journal of Canine Practice. 6: 158-160.

Manjunatha, D.R. and Ranganath, L. (2012). Occurrence of femur fracture in dog. Indian Veterinary Journal. 89: 116- 117.

Markel, M.D., Sielman, E., Rapoff, A.J. and Kohles, S.S. (1994). Mechanical properties of long bones in dogs. American Journal of Veterinary Research. 55: 1178-1183.

Minar, M., Hwang, Y., Park, M., Kim, S., Oh, C., Choi, S. and Kim, G. (2013). Retrospective study on fractures in dogs. Journal of Biomed Research. 14(3): 140-144.

Ozsoy, S. (2004). Fixation of femur, humerus and tibia fractures in cats using intramedullary threaded Steinmann pins. The Veterinary Record. 155: 152-155.

Patil, M., Desai, D., Shivaprakash, B., Kasaralikar, V., Ramesh, B. and Tikare, V. (2018). Prevalence of fracture in animals in Karnataka State: 4 years study. International Journal of Livestock Research. 8(3): 196-205.

Patil, M., Dilipkumar, D., Shivaprakash, B.V., Kasaralikar, V.R, Tikare, V.P and Ramesh, B.K. (2017). Physiological and haemato -biochemical changes during repair of femur fracture in dogs. The Pharma Innovation Journal. 6(8): 381-385.

Philips, R. (1979). A survey of bone fractures in the dog and cat. Small Animal Practice. 20: 661-674.

Priyanka, Singh, T., Mohindroo, J., Verma, P., Udheiya, R. and Umeshwori, N. (2019). Evaluation of intramedullary pinning technique for management of tibia fractures in dogs. The Pharma Innovation Journal. 8(2): 291-297.

Raghunath, M., Singh, M., Yadav, R.K. and Singh, S.S. (2007). Distribution and classification of canine long bone fractures. Indian Veterinary Journal. 84: 1243-6.

Rani, U.R., Kathiresan, D. and Vairavasamy, K. (2007). Fracture pattern of femur in canines and their surgical management. Indian Veterinay Journal. 84: 1310-12.

Raouf, M.A., Mekkawy, N.H.M. and AbdEl-Aal, A.M. (2017). Femur fractures and treatment options in 20 dogs admitted to our clinic from January 2013 to December 2015. Iraqi Journal of Veterinary Sciences. 31(2): 117-122.

Rhangani, A.T. (2014). Incidence, classification and management of appendicular bone fractures in dogs in Nairobi County, Kenya. A retrospective study. Doctoral dissertation submitted to the University of Nairobi. 22-31.

Rosol, T.J. and Capen, C.C. (1997). Calcium-regulating Hormones and Diseases of Abnormal Mineral (calcium, phosphorus, magnesium) Metabolism. In: Clinical Biochemistry of Domestic Animals, [Kaneko, J.J., Harvey, J.W. and Bruss, M.L. (eds)]. 5th edn, pp. 619-687. Academic Press, San Diego.

Shapiro, F. (2008). Bone development and its relation to fracture repair. The role of mesenchymal osteoblasts and surface osteoblasts. European Cells and Materials Journal. 15: 53-76.

Shiju, M.S., Ganesh, R., Ayyappan, S., Rao, G.D., Kumar, R.S., Kundave, V.R. and Das, B.C. (2010). Incidence of pelvic limb fractures in dogs: A survey of 478 cases. Veterinary World Journal. 3(3): 120-121.

Shiju, M.S., Ganesh, R., Ayyappan, S. and Kumar, R.S. (2011). Incidence of pectoral limb fractures in dogs: A survey of 331 cases. Tamilnadu Journal of Veterinary and Animal Sciences. 7 (2): 94-96.

Simon, M.S., Ganesh, R., Ayyappan, S. and Kumar, R.S. (2011). Incidence of pectoral limb fractures in dogs: A survey of 331 cases. Tamilnadu journal of Veterinary and Animal Sciences. 7(2): 94-96.

Simon, S., Ganesh, M.R., Ayyappan, S., Rao, G.D., Suresh Kumar, R., Kundave, V.R. and Das, B.C. (2010). Incidences of pelvic limb fractures in dogs: A survey of 478 cases. Veterinary World. 3(3): 120-121.

Singh, A.P., Mirakhur, K.K. and Nigam, J.M. (1983). A study on the incidence and anatomical locations of fractures in canine, caprine, bovine, equine and camel. Indian Journal of Veterinary Surgery. 4(1): 61-66.

Smith, G.K. (1985). Biomechanics Pertainent to Fracture Etiology, Reduction and Fixation. In: Textbook of Small Animal Orthopaedics. Newton CD and Neunamaker DM (eds). J.B. Lippincott, Philadelphia, pp. 195-230.

Vidane, A.S., Elias, M.Z.J., Cardoso, J.M.M., Come, J.A.S.S., Harun, M. and Ambrósio, C.E. (2014). Incidence of fractures in the dogs and cats in Maputo (Mozambique) between 1998 and 2008. Ciencia. Animal Brsileira Goiania. 15(4): 490-494.