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Original Research

Hospital Occurrence Pattern of Appendicular Fractures in Dogs for 3 consecutive years (2019-2021)

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Abstract

This retrospective study evaluated the hospital occurrence and bone wise signalment of appendicular fractures in dogs in the year 2019, 2020, and 2021. The study included 1242 canine patients. The overall hospital occurrence of appendicular fractures over the period of 3 years was 6.53%. The maximum number of cases (46.62%) were found to be presented in 2021. Higher prevalence of fracture was seen in non-descript (46.49%) and male dogs (66.46%). Automobile trauma was found to be the leading cause of fracture followed by fall from height. Immature dogs (less than 1-year-old) were found to be more susceptible to appendicular bone fractures. Fracture of hind limb with right sided bones were more common than forelimbs with left sided bones. Femur was the most common long bone to be fractured, constituting almost 40% of all the cases. Few uncommon fractures of patella and malleoli were also recorded. Majority of the fractures reported were closed and non-comminuted. Distal fractures were reported to be most common, followed by middle and proximal fractures.

The study concludes, an increase in occurrence of fractures every year. Juvenile dogs with hind limbs (femur bone) and distal region are more prone to fractures.

Keywords: Appendicular Fractures, Automobile Trauma, Dogs, Fall, Femur, Incidence, Occurrence.

Introduction

Recent increase in canine population in India, especially in urban cities due to current trend of keeping dogs as pets and increasing country's stray dog population (Singh *et al*., 2013) has led to increased traumatic incidents causing musculoskeletal injuries (Rouf *et al*., 2019). The 70% of these musculoskeletal disorders affect appendicular structures, out of which 75% are appendicular bone fractures (Johnson *et al*., 1994; Ness *et al*., 1996; Jain *et al*., 2018).

The canine appendicular fractures can be diagnosed via history, clinical signs, physical examination and radiographic assessment of the affected limb and can be further categorised including various parameters like type and site of bone affected, whethe(r the site of fracture interacts with the environment (open fractures) or not (closed fractures), degree of comminution etc. (Pierematteiet *al*., 2006; Fossum, 2018).

Enormous variation in size and weight of the bones in dogs due to different breeds and age prompts collection of a large data to formulate the plan for the type, material and size of implants or managemental practices which can be adopted in dogs having appendicular fractures (Braden *et al*., 1995; Abo-Soliman *et al*., 2020). To the knowledge of the authors, no such study for the geographical area of Punjab, India has been previously reported in literature. Keeping in view the above hypothesis, the present study was designed with the following objectives: -

1. To evaluate the hospital occurrence of appendicular fractures in dogs in 2019, 2020 and 2021
2. To evaluate the bone wise signalment of various appendicular fractures in 2019, 2020 and 2021

Material and Methods

A retrospective study on the appendicular fracture in canine patients presented to the Teaching Veterinary Hospital of Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana, Punjab, India was done for the period of three years i.e., 1st January, 2019 to 31st December, 2021. This study also included the time of lockdown by the Government of India due to COVID-19 pandemic i.e., during the year 2020, which affected the number of cases presented to the hospital due to travel restrictions.

Collection of Data

***The inclusion criterion*:** The required information was collected from clinical case records and radiographic records of the dogs presented during the period of study. The cases with the radiographic evidence of fracture were screened out and further, the cases with appendicular fractures were included in the current study.

***Signalment*: Breed;** Age and Gender of the dog;distance of travel by the owner to the facility; history including aetiology (automobile trauma, fall from height, dog bite, hit by another animal, hit by man, entrapment etc.), duration of trauma (days passed since the trauma happened), type of limb (forelimb or hind limb), side of limb (right or left), single or multiple limbs involved, classification of fracture as open (compound) or closed (simple) for each dog were recorded.

Radiography: The radiographs retrieved from the computerised radiography system were analysed to record the individual bones (scapula, humerus, radius-ulna, carpals, metacarpals, fore-phalanges, femur, tibia-fibula, patella, tarsals, metatarsals and hind phalanges) and combination of bones fractured.

The fractures were classified as comminuted or non-comminuted based on radiographic analysis. In long bone fractures, the site of fracture was classified as proximal, middle and distal one third (diaphyseal, supracondylar, unicondylar and intercondylar) (Pierematteiet *al*., 2006; Fossum, 2018). Avulsion fractures of anterior tibial tuberosity and tuber calcis of fibular tarsal bone were also recorded. Any associated orthopaedic ailment such as pelvic fracture, spinal fractures, joint dislocations etc. if any, were also recorded.

Categorisation and Statistical Analysis of Data

The entire data, was tabulated to categorise into multiple ways. The total number of cases of a particular bone or a combination thereof was tabulated for each year to get an overall incidence. This data was further categorised into

total number of appendicular fracture cases reported during each month of a particular year of study to get the month wise incidence and change in dynamics of fracture presentation during a particular month over the years and to infer the seasonality of appendicular fractures.

The data collected with respect to the presentation of appendicular fracture cases from various districts in Punjab and nearby states, in addition to those reported from the city, was categorised according to the distance in kilometers of a particular place from the hospital (50 Km to 400 Km). The incidence of fracture from nearby as well as remote areas was inferred.

The age of the dog was categorised into i.e. 2-4 months, 4-6 months, 6-12 months, 1-2 years, 2-5 years, 5-8 years and >8 years and the age of fracture was categorised as 1 day, 1-3 days, 3-6 days and >10 days old.

The data was analysed using Microsoft excel 2007 for the distributive analysis (mean and standard deviation) and the subjective data was analysed based on percentage

Results

Objective 1: To evaluate the hospital occurrence of appendicular fractures in dogs in 2019, 2020 and 2021

Year/bone wise pattern of occurance: A total of 1242 fractures were recorded in a period of 3 yrs. The maximum number of dogs with fractures were presented in 2021 and the minimum in 2020 which could be attributed to the lockdown in the year 2020 due to the Covid-19 pandemic. The detailed number of the cases presented is shown in table 1.

In 2019, 2020 and 2021, out of 6000, 5500 and 7500 dogs were presented respectively, for various surgical affections. 358 dogs in 2019, 305 dogs in 2020 and 579 dogs in 2021 were diagnosed with appendicular bone fractures. Hence, hospital occurrence of appendicular bone fractures was accounted to be 5.97%, 5.54% and 7.72 % in the year 2019, 2020, 2021, respectively.

Table 1: Table showing the Bone wise fracture presentation in 3 years

S. No	Bones	2019	2020	2021
1	**Scapula**	0	2	0
2	**Humerus**	29	23	51
3	**Olecranon**	1	0	2
4	**Only Radius**	6	3	7
5	**Only Ulna**	1	0	3
6	**Radius + Ulna (RU)**	70	86	105
7	**RU + Tibia**	2	1	0
8	**RU+ Tibia+ Fibula**	0	0	1
9	**RU + Femur**	1	2	2
10	**Humerus + femur**	2	0	2
11	**Humerus+ Radius**	0	0	1
12	**Humerus +RU**	1	0	2
13	**Humerus+ Tibia+ Fibula**	0	0	2
14	**Humerus + tibia**	1	1	0
15	**Humerus + Ulna**	0	1	0
16	**Carpal**	0	2	0
17	**Metacarpal (MC)**	8	6	10
S. No	**Bones**	**2019**	**2020**	**2021**
18	**Metacarpal+ RU**	1	1	0
19	**Humerus+ Scapula+ MC**	0	1	0
20	**Fore Phalanges**	1	1	2
21	**Femur**	156	99	247

22	**Patella**	0	0	1
23	**Tibia + Fibula**	63	59	76
24	**Only fibula**	1	0	0
25	**Only Tibia**	2	3	39
26	**Femur+ tibia fibula**	4	10	10
27	**Femur + Tibia**	0	0	3
28	**Tibial Tuberosity**	2	1	3
29	**Fibular Tarsal**	2	0	3
30	**Tarsals**	1	0	2
31	**Malleolus**	0	1	1
32	**Metatarsals**	3	2	4
	Total	**358**	**305**	**579**

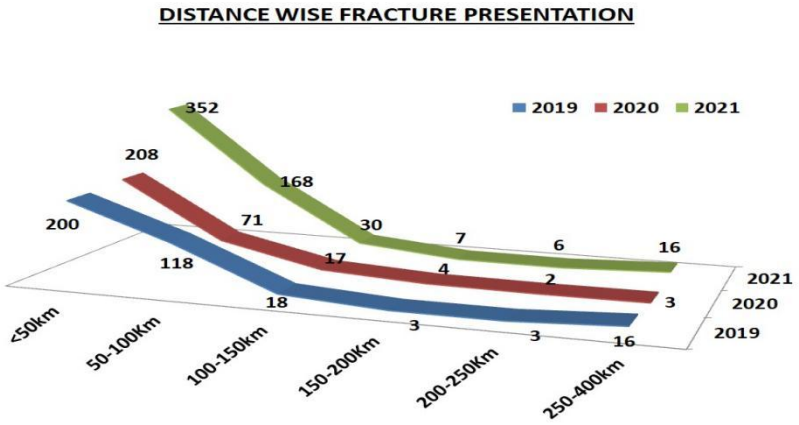
The hospital occurrence of appendicular fractures increased in 2021 which may be accounted to a greater number of dogs being kept as pet during or after lockdown but also corresponds to the greater number of NGO's getting started during the lockdown and bringing street dogs for treatment to the hospital.

A total of 32 type of individual or in combination fractures of appendicular bones were recorded. The highest number of fractures were of femur bone (n=502, 40.42%) in all the 3 years, followed by the radius and ulna (18-28%) and tibia fibula (17-42%) (Aithal *et al*., 1999; Kumar *et al*., 2007; Rouf *et al*., 2019). The number of tibia and fibula fractures increased to almost 3 times in the year 2021 as compared to 2019. The short bones, single bones among the twin bones or a combination of long bones fractures were less encountered.

Overall occurrence of hind limb appendicular fractures was found to be remarkably more (67.58%) than the forelimb fractures (32.42%) indicating that the canine patients are more prone to hind limb fractures. The hindquarter is expected to be more exposed to trauma if the dog tries to flee the spot. Another reason for less forelimb appendicular fractures could be the associated trauma to chest or head leading to fatal injuries (Harasen, 2003; Minar *et al*., 2013 and Jain *et al*., 2018)

Among dogs having multiple bone fractures involving fore and hind limb both; 61.82% of dogs had ipsilateral limb fractures and 16.36% dogs had contralateral limb fractures. With dogs having 3 limbs involvement, the bilateral hind limbs (18.18%) were more fractured compared to bilateral forelimbs (3.6%).

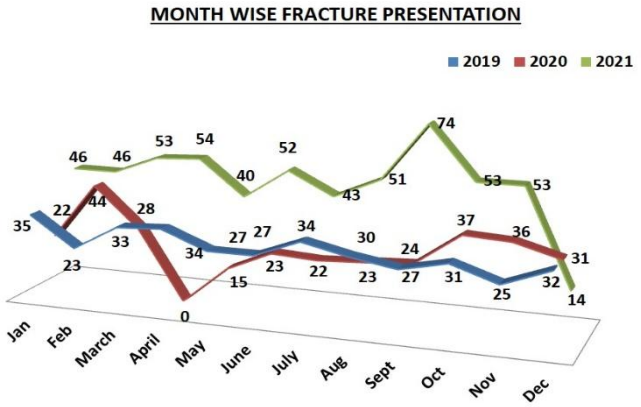
Distance wise occurrence: Majority of the dogs (61.19%) presented were from within 50 km radius to the hospital, with Ludhiana being the epicentre corresponding towards 58.69% of total cases reported. The detailed occurrence is shown in Fig. 1.



38.81% dogs were presented from distant areas (>100 km radius from the epicentre), with a few cases presented from remote and border areas of the state. Over a period of 3 years, 3.38 % dogs were presented from adjoining states (Himachal Pradesh, Uttarakhand, Haryana, Rajasthan and Delhi).

The number of cases of appendicular skeleton fracture presented from distant places were less in the year 2020 as compared to 2019 and 2021. The probable reason for this could be strict travel restrictions during this year due to the pandemic.

Month wise fracture occurance pattern: Month wise distribution of fracture areas is depicted in Fig. 2. From the above graph it was inferred that high incidence of appendicular fracture over 3 years of study period could not be accredited to a particular month of the year. Subsequent rise in the number of cases reported in a particular month from 2019 to 2021 is probably due to a greater number of cases presented in 2021 as compared to 2019 and 2020.



Objective 2: To evaluate the bone wise distribution of various appendicular fractures presented in 2019, 2020 and 2021 (Table 2)

Forelimb

Scapula bone: Two cases of closed scapula fracture were reported in the year 2020; one year-old male German Shepherd (right) with fracture of supraglenoid tubercle and a 5-year-old male pug (left) with distal third fracture. Automobile trauma was the cause of fracture in both the cases and were presented on the same day ~~as the day~~ of trauma.

Humerus bone: Majority of the humerus fractures were reported in up to one-year-old dogs with non-descript breeds being maximum presented (24.14% in 2019, 16.95% in 2020 and 27% in 2021) followed by Labradors (17.24%) in the year 2019 and German shepherds in the year 2020 (8.70%) and 2021 (3.92%). Occasional cases (1-3) were also observed in other breeds such as GSD (German Shepherd), Rottweiler, Pitbull, French Bulldog, Husky, Pomeranian, Shih Tzu, Pug, Dachshund, Pointer, Beagle, Boxer, Gaddi, Golden Retriever, Doberman, and Bull terrier.

Automobile trauma was the major etiological reason for the humerus fracture followed by unknown aetiology and dog bite. Majority of the cases were presented as early as within 1-3 days from the day of injury. Males were over-presented (58.62% in 2019, 69.56% in 2020 and 62.74% in 2021) as compared to females, probably due to higher male dog population amongst stray (Gill *et al*., 2022) and pet dogs in the region of study.

Majority of the humeral fractures were closed (93.2%) with both sides being almost equally presented. Single case of bilateral humerus fracture was also presented every year. Majority of fractures recorded were non-comminuted and only 7.76% were comminuted. Distal diaphysis was most commonly affected site, followed by midshaft, proximal and supracondylar regions

Olecranon bone: In 2019, a single, closed, proximal fracture of right olecranon was reported in a 9 years old, male pug with the history of automobile accident 3-6 days ago.

In 2021, two non-descript dogs, male and female each, aged between 1-2 years, having a history of automobile trauma 3-6 days ago were presented with closed fracture of left olecranon.

Only Radius: A total of 16 only radius fractures were presented (n=6 in 2019, n=3 in 2020, n=7 in 2021) with automobile trauma being the major aetiology. Non-descript breeds were most commonly affected (31.25%) followed by Pomeranians (25%) and German shepherds (18.75%). Less than one-year-old dogs were mostly presented for only radius fracture with delay in presentation for more than 10 days of trauma owing to partial weight bearing due to intact ulna bone.

Only Ulna: 2019 (n=1): A closed, middle third diaphyseal fracture of right ulna was reported in a one-year-old, male, ND breed with a history of automobile trauma 3 days ago.

2021 (n=3)**:** Closed fracture of left (n=2) and right (n=1) Ulna was reported in a ND breed aged 1 year**,** a Siberian Husky aged 2 years and a Pomeranian aged 6 years, out of which 2 were males and 1 was female. Vehicular trauma was the cause in all the three cases, which were presented within 3 days of trauma. The site of fracture was proximal one third diaphysis, middle one third diaphysis and distal one third diaphysis in 3 dogs respectively.

Radius and Ulna: The maximum dogs (42.5 %) were Non-descript, followed by racing hounds (15.32%), and Pomeranians (13.41% in 2021). Other breeds reported occassionally were; American Bully, Labrador, Rottweiler, Pit Bull, Saint bernard, Shih Tzu, Pug, Dachshund, Pointer, Beagle, Gaddi, Golden retriever, Dalmatian, Pakistani Bully, and Doberman. Accident was the leading cause of trauma followed by fall from height. Racing, dog bite, hit by man were among the other uncommon aetiologies.

Dogs less than one year were found to be most susceptible to radius-ulna fractures with majority of them belonging to 6-12 months' age group. Most of the dogs (35.63%) were presented within 1-3 days' post injury. A substantial number (27.49%) of cases were delayed by more than 10 days. Male patients dominated females. Closed fracture prevailed over open fractures, however, substantial number of cases (n=12 in 2019, n=5 in 2020 and n=7 in 2021) were presented with open fractures.

Right and left limbs were almost equally presented, with right side cases being slightly more than left side and 7.66% had bilateral fracture. Non-comminuted and distal diaphyseal fractures of radius-ulna were the most commonly recorded. Radius-ulna fractures were also found to be associated with metacarpal fractures in 3 cases.

Radius ulna+ Tibia (n=3): In 2019, a 3 months old, female ND dog with a history of dog bite and a 2.5 years old, male Pitbull with a history of automobile trauma were presented with radius-ulna and tibia fractures in left fore and right hind limbs respectively. Both the fractures were reported after 5-6 days injury. The fracture of tibia was open in ND dog due to dog bite. Distal one third diaphyseal fracture of radius-ulna was reported in both the cases, whereas, one proximal third diaphyseal and one distal third diaphyseal fracture was reported in tibia. None of the fracture reported were comminuted.

In 2020**,** a closed, non-comminuted, bilateral proximal one third diaphyseal radius ulna fracture and distal one third diaphyseal tibia fracture was reported in a 2 months old ND dog with the history of being hit by another animal 2 days before the day of presentation.

No such case was presented in the year 2021.

Radius ulna + Tibia fibula: One case of closed, non-comminuted, middle one third diaphyseal fracture of right radius-ulna and contralateral tibia-fibula was reported in 2021 in an 8 months old, male ND dog with a history of automobile trauma 8 days before the day of presentation.

Radius ulna+ Femur: In 2019, a case of closed, non-comminuted middle one third diaphyseal fracture of right radius-ulna and distal one third diaphyseal fracture of ipsilateral femur was observed in a 10 months old, male ND dog, hit by a vehicle 3 days before the day of presentation.

Table 2: Table showing the signalment of long bone appendicular Fractures in dogs

		Humerus			Radius and Ulna			Femur			Tibia fibula		
		2019 (n=29)	**2020 (n=23)**	**2021 (n=51)**	**2019 (n=70)**	**2020 (n=86)**	**2021 (n=105)**	**2019 (n=156)**	**2020 (n=99)**	**2021 (n=247)**	**2019 (n=60)**	**2020 (n=59)**	**2021 (n=76)**
ETIO-LOGY	**Accident**	**12, 41.38%**	**18, 78.26%**	**39, 76.47%**	**41, 58.57%**	**60,69.77%**	**81,77.14%**	**106, 67.95%**	**62, 62.63%**	**183, 74.09%**	**34, 53.97%**	**47,79.66%**	**66, 86.84%**
	Fall	4, 13.79%	1	4, 7.84%	15, 21.43%	15,17.44%	15,14.29%	24, 15.38%	15,15.15%	35, 14.17%	4, 6.35%	8,13.56%	8, 10.53%
	Racing/entrapment				5, 7.14%		3	1	1	1	1		1
	Dog bite	2	**2**	5, 9.8%		4	1	4	1	6	6		
	Hit by Man/ animal	1	1	1	1	3	3	2	1	4	1	3	1
	Unknown	10, 34.48%	1	2	8, 11.43%	4	2	19, 12.18%	19, 19.19%	18, 7.29%	17, 26.98%	1	
AGE OF DOG	**2-4m**	6, 20.69%	5, 21.74%	8, 15.69%	4, 5.71%	8, 9.3%	13, 12.38%	**31, 19.87%**	24, 24.24%	**76, 30.77%**	11, 17.46%	**15, 25.42%**	**17, 22.37%**
	>4-6m	6, 20.69%	2	**15, 29.41%**	6, 8.57%	7, 8.14%	13, 12.38%	28, 17.95%	17, 17.17%	45,18.22 %	7, 11.11%	7, 11.86%	9, 11.84%
	>6-12m	1	**7, 30.43%**	11, 21.57%	**18, 25.71%**	22, 25.58%	**34, 32.38%**	29, 18.59%	**27, 27.27%**	58, 23.48%	**16, 25.39%**	10, 16.95%	16, 21.05%
	>1y-2 yr	3, 10.34%	3, 13.04%	3, 5.88%	17, 24.28%	18, 20.93%	16, 15.24%	25, 16.02%	10, 10.10%	16, 6.48%	6, 9.52%	6, 10.17%	13, 17.10%
	>2-5yrs	**9, 31.03%**	4, 17.39%	8, 15.69%	16, 22.86%	**25, 29.07%**	21, 2%	18, 11.54%	9, 9.09%	22, 8.91%	16, 25.40%	3, 5.08%	10, 13.16%
	>5-8yrs	3, 10.34%	2	4, 7.84%	6, 8.57%	5, 5.81%	5, 4.76%	16, 10.26%	8, 8.08%	11, 4.45%	7, 11.11%	14, 23.73%	6, 7.84%
	>8yrs	1		2	2	1	3, 2.86%	9, 5.77%	4	19, 7.69%		4, 6.78%	5, 6.58%
AGE OF FRAC-TURE	**1days**	2	2,	3	11	12	7	20	8,	32	7	2	8
	1-3 days	**12**	**7**	**22**	**25**	**26**	**42**	**80**	**50,**	**100**	**29**	**34**	**27**
	3-6 days	9	7	11	12	12	26	34	12	57	11	10	25
	6-10 days	2	6	4	8	10	3	9	10	24	8	3	8
	>10 days	4	4	11	14	26	27	13	19	34	8	10	8
TYPE OF FRAC-TURE	**Proximal**	4	2	5	7	10	12	44	15	48	21	11	15
	Midshaft	5	10	18	19	20	38	70	35	88	7	22	42
	Distal	11	6	19	44	56	55	4	31	59	13	19	19
	Intercondylar		2	8									
	Unicondylar	1											
	Supracondylar	6	3	1				30	14	30			
	Femur neck							6	4	18			
	Femur capital							2	0	4			
	Comminuted	4	1	3	7	4	18	31	14	62	6	6	8
	Non-Comminuted	23	22	48	63	82	87	125	85	185	57	57	51

***The coloured boxes highlight the maximum number of cases in that categoryThe males outnumbered females with only closed fracture of radius. Right radius was more affected in 2019 and 2021, however, in 2020, left radial fracture outnumbered the right side with no report of bilateral radial fracture in this particular year of study. All the radial fractures (except one) were non-comminuted and had distal diaphyseal fracture (50%) followed by mid diaphyseal fracture (37.5%).*

In 2020, a combination of radius-ulna and femur fracture was reported in two 3 months old, ND, male dogs with the history of automobile trauma and were presented within 1-3 days of injury to the hospital. One of the dogs suffered from closed, non-comminuted, proximal one third diaphyseal fracture of left radius-ulna and left femur. The other dog suffered from closed, non-comminuted, distal one third diaphyseal fracture of right radius-ulna and closed, comminuted middle one third diaphyseal fracture of left femur.

Radius ulna+ Femur: In 2019, a case of closed, non-comminuted middle one third diaphyseal fracture of right radius-ulna and distal one third diaphyseal fracture of ipsilateral femur was observed in a 10 months old, male ND dog, hit by a vehicle 3 days before the day of presentation.

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In 2021, similar fractures were reported in a 2 months old, female ND dog and a 5 months old, male German Shepherd (GSD), both having a common history of falling from height and were presented within 1-3 days post trauma. The ND dog had a closed, non-comminuted, middle one third diaphyseal fracture of right radius-ulna and the GSD had closed, comminuted, proximal one third diaphyseal fracture of contralateral femur. The GSD was also diagnosed with closed, non-comminuted, middle one third diaphyseal fracture of right radius-ulna and distal one third diaphyseal fracture of ipsilateral femur.

Humerus + Femur: In 2019, humerus as well as femur fracture was reported in two male ND dogs of age 1 and 6 years and had a history of vehicular trauma 1-3 days before. One of the dogs suffered closed, non-comminuted, distal one third diaphyseal fracture of bilateral humerus and middle one third diaphyseal fracture of left femur, whereas the other dog suffered from closed, non-comminuted, middle one third diaphyseal fracture of left Humerus and proximal one third diaphyseal fracture of ipsilateral femur.

In 2021, a 1-year-old, male, ND dog with a history of dog bite was presented within 1-3 days' post bite with closed, non-comminuted, supracondylar fracture of right humerus and comminuted, middle one third diaphyseal fracture of ipsilateral femur. Another 3 months old female Labrador with the history of falling from height was presented within 1-3 days of trauma with closed, non-comminuted distal one third diaphyseal fracture of left humerus, supracondylar fracture of right femur and middle one third diaphyseal fracture of left femur in the same year.

Humerus + only Radius: In 2021, a closed, non-comminuted distal one third diaphyseal fracture of left humerus and middle one third diaphyseal fracture of ipsilateral radius was reported in a 3 years old, male, ND dog with the history of automobile trauma 2 days before the day of presentation.

Humerus + Radius Ulna: In 2019, a 5 months old, male, ND dog with a history of 5 days old trauma from vehicular accident was presented with closed, non-comminuted, proximal one third diaphyseal fracture of right Humerus and bilateral middle one third diaphyseal radius-ulna fracture.

In 2021, a 5 months old, male**,** Siberian Husky with a history of automobile trauma 10 days before the day of presentation suffered from closed, non-comminuted, supracondylar fracture of right Humerus and middle one third diaphyseal fracture of ipsilateral radius-ulna. Another 8 months old, female Pomeranian suffered from the similar fracture as in husky of right Humerus and radius-ulna due to fall from height 8 days before the day of presentation.

Humerus + Tibia fibula: In 2021, a 5 months old, female ND dog with a history of 2 days old vehicular trauma was diagnosed with closed, comminuted, middle one third diaphyseal fracture of right humerus and contralateral tibia-fibula. Another 7 months old, female ND dog with a history of 6 days old vehicular trauma suffered from open, non-comminuted, middle one third diaphyseal fracture of right humerus and ipsilateral tibia-fibula and closed, non-comminuted, proximal one third diaphyseal fracture of contralateral tibia in the same year.

Humerus + only Tibia: In 2019, a year old, male, ND dog with a history of automobile trauma two days before the day of presentation was diagnosed with closed, non-comminuted, distal one third diaphyseal fracture of left

Humerus and tibia.

In 2020, a closed, non-comminuted, middle one third diaphyseal fracture of right Humerus and contralateral tibia was recorded in a 8 months old, female, ND dog with a history of falling from height one day before being presented to the hospital.

Humerus + only Ulna: A closed, non-comminuted, distal diaphyseal fracture of right humerus and right olecranon fracture was recorded in a year old, male ND dog with the history of 8 days old vehicular trauma in 2020.

Carpals: A 2 years old, male, ND dog and a 5 years old, female, Pomeranian with a history of accident 2 days and 8 days before the day of presentation respectively, had closed fracture of right side carpal bones in 2020.

Metacarpals (MC): Majority of the cases reported were in ND dogs over 3 years in 2019 and 2020 however, in 2021, 4-6 months old dogs were maximum presented with primary aetiology as automobile trauma. A case of fracture due to dog bite was reported in 2020. Maximum number of cases were reported within 1-3 days of trauma. Males as per the trend, outnumbered females in this case as well and all fractures except one (in the year 2019) were closed. In these cases, left metacarpals were more affected than right in general and right was more affected in particular for the year 2019. Single case of bilateral metacarpal fracture was reported in 2019 and in 2021. None of the fractures were comminuted. Middle one third diaphysis was the most commonly affected site.

Metacarpal + Radius Ulna: A closed, non-comminuted middle one third diaphyseal fracture of right radius-ulna and metacarpal was reported in an 8 months old, male, ND dog with a history of a day old trauma due to vehicular accident in 2019.

In 2020, a 5 months old, male, ND dog suffered from a closed, non-comminuted, middle one third diaphyseal fracture of right metacarpal and distal one third diaphyseal fracture of ipsilateral radius-ulna due to automobile accident 2 days before the day of presentation.

Humerus+ Scapula +Metacarpal: A closed, non-comminuted, intercondylar fracture of left humerus, acromion process fracture of left scapula and proximal one third diaphyseal fracture of metacarpal of same side was observed in an 8 months old, male pug with a history of 6 days old vehicular trauma in 2020.

Fore phalanges: A closed fracture of right fore-phalanges was recorded in a 5 months old Pomeranian and an 8 months old Rottweiler with a history of 2 days and 3 days old vehicular trauma in the year 2019 and 2020 respectively.

In 2021, a closed fracture of right and left fore-phalanges was observed in a male ND and a female Beagle dog, both aged 5 months with a history of falling from height 3 and 5 days before the day of presentation respectively.

Hindlimb

Femur: The majority of the dogs (44.23% in 2019, 47.47% in 2020 and 49.39% in 2021) presented were ND**,** followed by GSD in 2019 (13.46%); in 2020 (11.11%) and Labradors in 2021 (8.50%). Pomeranians accounted for 11.11% cases of all the femur fractures reported and hence, were also commonly presented. Occasionally affected breeds in all 3 years were Rottweiller, Siberian Husky, Saint Bernard, Shih Tzu, Pug, Pitbull, Dachshund, Pointer, Beagle, Spitz, Boxer, Gaddi, Cocker Spaniel, Mastiff, Golden Retriever and Pakistani Bully.

Automobile trauma was the major aetiology. In the present study, 66.73% dogs were less than a year old, out of which majority belonged to 2-4 months old age group**.** Majority of the cases (45.82%) were reported within 1-3 days post trauma. Only 12% cases were reported on the same day of injury. Percentage of males presented was almost twice as that of females.

Less than 10% cases were open. The right limb involvement was highest (56.41% in 2019, 50% in 2020 and 45.34% in 2021) and 6.41, 8.08% and 6.07% cases in 2019, 2020 and 2021 respectively had bilateral femur fracture.

Most of the dogs (78.68%) had non-comminuted femur fracture. Mid diaphysis was the most common fracture site, followed by proximal diaphysis and supracondylar fractures in 2019, distal diaphyseal and proximal femur fractures

in 2020 and 2021. A few cases of femur neck and capital fractures were also recorded. Pelvic fracture was found to be the most common orthopaedic ailment (8.33% cases in 2019, 8.08% cases in 2020 and 6.48% cases in 2021) associated with femur fracture. A few cases were also associated with sacroiliac joint dislocation, spinal fracture, femur head dislocation and phalangeal fracture ~~were also recorded.~~

Patella: Left patella fracture was observed in 3 years old, male, American Bully with a history of 10 days old trauma due to strenuous exercise in 2021.

Tibia + Fibula: ND dogs was mostly affected (41.41% cases) followed by Pomeranian and Labrador. The accident was the major reason for the fracture. In accordance with the results of above explained data, majority of the cases were reported from dogs less than a year old with highest incidence in 2-4 months' age group. Most of the cases were presented within 1-3 days of trauma. As previously observed, a greater number of cases were observed in males as compared to females with 10.6% cases having open fracture. None of the cases reported in the year 2019 had open fracture. Except in 2019, right limb was most commonly affected than left limb with 4.54% cases having bilateral involvement of tibia and fibula and total of 85.87% fractures were non-comminuted. Most common site of fracture was proximal one third diaphysis in the year 2019, middle one third diaphysis in the years 2020 and 2021. Pelvic fracture was seen in 2.52% cases and a single case also had concurrent spinal fracture.

Only fibula: Closed, non-comminuted, middle one third diaphyseal fracture of right fibula was recorded in a 5 months old, male ND dog in 2019. The cause of fracture was automobile trauma that happened 2 days before.

Only tibia (n=44): The year 2021 had 88.64% of only tibia cases (n=39). In 2019, two cases reported belonged to German Shepherd and Beagle breeds and fracture resulted from accident. In 2020, fracture was reported in ND, Rottweiler and Siberian Husky with automobile trauma. In 2021, ND dogs outnumbered other breeds (38.46%) The two cases reported in the year 2019 were between 1-2 years old and between 5-8 years old and were presented after 10 days ~~from the day~~ of injury. All the 3 cases in year 2020, belonged to 2-5 years old age group and were presented within 1-3 days of injury. Majority of the cases reported in 2021 were less than one-year-old and were presented within 1-3 days of injury. Age of fracture could not be ascertained in one case presented in the year 2021.

Males were over presented than females with right hindlimb more commonly affected. All cases in 2019, 2020 and 92.31% cases in 2021 had closed fracture. All the fractures reported in the year 2019 and 2020 were non-comminuted and 4 cases in the year 2021 had comminuted fracture. Majority of the cases reported suffered from middle one third diaphyseal fracture. 1 case each in 2019 and 2021 suffered concurrent lumbo-sacral spinal fracture and pelvic fracture respectively.

Femur + Tibia + Fibula: This combination of fracture was reported in a total of 24 cases with majorly involving ND dogs where maximum number of dogs were less than a year old. Automobile trauma was the prime cause followed by fall from height, entrapment and hit by person. The fractures in majority of the cases were 1-3 days old on presentation and as usual males outnumbered females in general with equal number of males and females being affected in particular in the year 2019. None of the fractures reported were open. Incidence of femur and tibia fracture was high in left limb as compared to right limb. Bilateral femur fracture was reported in 1 case in 2020 and 2 cases in 2021, whereas 1 case of bilateral tibia fracture was reported in 2020 and 2021.

In 2019, 75% cases had middle diaphyseal femur and proximal tibia fractures. 1 case each of supracondylar femur and distal tibia fracture were also recorded. In 2020, 40% cases reported had distal femur fracture and proximal and distal tibial fracture. 20% of reported cases had supracondylar femur fracture and 30% had femur neck fracture. In 2021, majority of cases had proximal femur and middle diaphyseal tibia fracture. 5 cases in 2020, 3 cases in 2021 had comminuted tibia fracture and 4 cases in 2021 had comminuted femur fracture.

Three cases in 2020 and 1 case in 2021 had associated pelvic fracture. 1 case in 2021 also had concurrent tarsal fracture.

Femur + tibia (n=3): In 2021, 3 ND dogs (2 males and one female), aged 3 months, 6 and 10 months respectively, with history of accident were presented within 1-6 days post trauma with closed, non-comminuted fracture of bilateral femur with involvement of proximal one third diaphysis in right femur and distal one third diaphysis in left femur and a proximal one third diaphyseal fracture of right tibia in a 3 months old dog and closed, non-comminuted

middle one third diaphyseal fracture of right femur and tibia in both 6 and 10 months old dogs.

Tibial Tuberosity (n=6): In 2019, avulsion fracture of right tibial tuberosity was seen in a 9 months old female grey hound with a history of race and was presented within 3-6 days' post trauma. Another case of left tibial tuberosity avulsion fracture was observed in a 3 months old, male, Pomeranian with unknown history and was presented within 3 days of showing lameness in the affected limb.

In 2020, the tibial tuberosity avulsion fracture of left side was observed in a 5 months old, female Pomeranian with a history of falling from height 10 days before presentation.

In 2021, 3 male dogs (a 3 months old Pitbull and two hounds aged between 8-10 months of age) were presented with a history of running and unknown trauma within 10 days of injury and were diagnosed with avulsion fracture of 2 right and one left tibial tuberosity.

Fibular tarsals (n=5): In 2019, fibular tarsal avulsion fracture was reported in a 6 months old, male hound and a 3 years old ND dog with a history of trauma while racing in hound, whereas the history of trauma was unknown in the ND dog. Both the cases were presented within 3-6 days of observing lameness on the affected limb. Right fibular tarsal was affected in hound, whereas in ND dog, left fibular tarsal was affected.

In 2021, 3 male dogs (2 hounds and one GSD) with a history of accident, fall and race, aged between 3-6 months were presented within 10 days of observing lameness for closed fracture of left fibular tarsal.

Tarsals (n=3): In 2019, one 5 months old, male ND dog was presented after accident within 5 days with closed fracture of right tarsal bones.

In 2021, 2 male dogs, one 5 months old ND dog and one 3 years old Dachshund with a history of accident was presented after 3-10 days with closed fracture of left tarsals.

Malleolus (n=2): In 2020, a 4 years old, male hound was presented with a unknown history after one day of showing lameness in right hind limb and was diagnosed for closed fracture of right medial malleolus.

In 2021, a 4 year old, male American Bully was presented with a history of accident after 3 days and was diagnosed for closed fracture of lateral malleolus of right side.

Metatarsals (n=9): In 2019**,** 3 male dogs, a German shepherd aged 9 years, a ND dog aged 13 years and a hound aged 2 years, presented within 3-8 days of being hit by another animal in case of German Shepherd and being hit by a vehicle in the other two cases, were diagnosed with closed, non-comminuted fracture of right metatarsals. The site of fracture was middle one third diaphyseal in GSD and ND dog and proximal one third diaphysis in a hound.

In 2020, 2 ND dogs (male, 3 months and female, 2 years of age) , were presented with the history of accident after 8-10 days and were diagnosed for one right proximal and one left middle one third diaphyseal closed fracture of more than one metatarsal.

In 2021, 3 males, ND dogs and 1 male, Labrador, aged between 6-10 months and 5-8 years were presented with the history of accident after 6-8 days and were diagnosed with the one open and 3 closed proximal (1 dog), middle (2 dogs) and distal (1 dog) one third diaphyseal fractures of more than one metatarsal including de-gloving injuries. Occurrence of fracture between right and left limb was equal.

Discussion

Overall, the highest occurrence of appendicular fracture was found to be in ND dogs, (Aithal *et al*., 1999; Singh *et al*., 2017; Jain *et al*., 2018; Abo-Soliman *et al*., 2020). This could possibly be due to high stray dog population in India and increased activity of animal welfare NGOs over the past few years which might have led to increased presentation of ND dogs. However, few studies with smaller number of cases reported Spitz and German shepherd respectively, to be most commonly affected breeds for fractures (Kumar *et al*., 2007; Abd El Rouf *et al*., 2019). In the present study, hounds were reported to have higher incidence of forelimb fractures to occupy third position in breed incidence after ND and Pomeranian for cases of forelimb fractures.

The dogs younger than one year of age had the highest incidence of fracture with majority presented under the age group of 6-12 months for forelimbs and 0-4 months for hind limb fractures, (Minar *et al*., 2013; Singh *et al*., 2017; Jain *et al*., 2018). The thinner cortices in young dogs, due to mineral deficiency (Aithal *et al*., 1999) or metabolic bone disease (Kushwaha *et al*., 2003) or fast growth in large breeds could be the reasons for it. However, it has also been reported that the elasticity in young animals may also prevent occurrence of fracture in young animals, (Torzilli *et al*., 1981).

Automobile trauma was found to be the leading cause of appendicular bone fractures in dogs (Aithal *et al*., 1999; Jain *et al*., 2018; Abo-soliman *et al*., 2020), with a few reports having fall from height (Abd El Rouf *et al*., 2019) as the major aetiology. Other less common aetiological factors may include dog bite, being hit by a man or any other animal, racing/running or entrapment. Radius ulna fractures in grey hound dogs are the most common due to racing.

Males were over presented (Phillips, 1979; Jain *et al*., 2018) as compared to females which could be attributed to the preference of public towards male dogs or due to their aggressive nature and wandering habits (Abd El Rouf *et al*., 2019). Slightly higher incidence of fracture was seen in bones of right side as compared to left side, (Balagopalan *et al*., 1995; Jain *et al*., 2018).

Maximum number of fractures are reported closed, Singh et al (2017) and non-comminuted (Minar *et al*., 2013; Abo-Soliman *et al*., 2020). Most of the open fractures are reported in forelimbs. Femur, despite being overlaid by heavy musculature (Beale, 2004; Braden *et al*., 1995) was affected more than other bones of hindlimb.

In general, distal diaphyseal fractures were the most common, followed by middle and proximal diaphyseal fractures (Minar *et al*., 2013) in forelimbs. However, middle diaphyseal fracture are most common fracture in hind limbs (Abd Al Rouf *et al*., 2019; Abo-Soliman *et al*., 2020)

From this retrospective study, it was concluded that:

1. The appendicular bone fractures were more prevalent in immature, male and non-descript dogs.
2. Automobile trauma was the most common cause of fracture.
3. Incidence of pelvic limb bone fractures is more compared to pectoral with femur most commonly fractured long bone.
4. Closed, non-comminuted, distal diaphyseal fractures are common in dogs.

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Contribution by Authors

Each co-author contributes equally.

Conflict of Interests

There is no conflict of interest.

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