International Journal of Veterinary Sciences and Animal Husbandry

ISSN: 2456-2912
VET 2023; 8(6): 223-227

www.veterinarypaper.com
Received: 07-10-2023
Accepted: 09-11-2023

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Incidence of long bone fractures in birds: A retrospective study

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DOI: https://doi.org/10.22271/veterinary.2023.v8.i6d.841

Abstract
Long bone fractures represent a prevalent orthopedic condition in avian practice, and understanding their various types and incidence in birds is crucial for advancing surgical techniques in fracture fixation. This retrospective study, conducted at the Orthopedic Outpatient Unit of Madras Veterinary College from October 2022 to October 2023, analyzed 89 bird fracture cases. Incidence was assessed based on age, etiology, fractured limb, fractured bone, type of fracture, and fracture location. The study revealed that 64.04% of fractures occurred in the pelvic limb, while 35.96% were in the wing. Birds belonging to the Psittaciformes order were frequently observed, accounting for 40.45% followed by Galliformes 31.46%. Tibiotarsal bone fractures (43.82%) were most common, followed by radius and ulna fractures (16.85%). The majority of fractures were situated in the mid-shaft (61.80%) of the bone, with the proximal 3rd region accounting for 25.84%. Oblique fractures predominated at 49.44%, followed by transverse fractures at 44.9%. The highest incidence of fractures occurred in the 6 to 12-month age group (50.56%) and ceiling fan injury was identified as the primary cause in 52.81% of cases.

Keywords: Long bone fracture, incidence, pelvic limb, wing

1. Introduction
Long bone fractures in avian species represent a significant concern for both wildlife and companion birds. Avian bones have thin and brittle cortex due to their high calcium content, resulting in an increased incidence of open, comminuted fractures that can be traumatic to the surrounding soft tissues (Jones, 2013) [1]. Avian bones contain an extracellular matrix primarily composed of hydroxyapatite crystals, consisting of 85% calcium phosphate and 10% calcium carbonate. This high hydroxyapatite content makes avian bones more fragile compared to mammals, rendering them susceptible to fragmented fractures (Tully, 2002) [2]. These fractures can have detrimental effects on the overall health, mobility, and even survival of the birds. Investigating the incidence of long bone fractures in birds is crucial for enhancing our knowledge of avian orthopedics and helps advance surgical fixation techniques. Leg fractures were more common in cage-rearing birds than wing fractures (Arnall *et al.*, 1975, Islam *et al.*, 2002) [3, 4]. Tibiotarsal fractures are the most common fractures seen in companion bird practice mainly due to mishandling, cage-related trauma, and injuries caused by other pets in the household (Harcourt-Brown 2002, Rosskopf 2003, Eshar and Briscoe 2009, Wright *et al.* 2018) [5-8]. Forearm fractures (41%) were more commonly reported in common buzzards mainly during hunting season and the highest mortality was reported in birds having comminuted lesions (Carneiro *et al.*, 2009) [9]. Avian bones are very much vulnerable to various metabolic diseases that lead to fractures created by external violence like mechanical injury, blows, bites by other animals, and automobile accidents (Islam *et al.*, 2002) [4]. Falling, an impaction with a window or ceiling fan, and a crushing incident such as being stepped on and bitten by other animals were the most frequent causes of orthopedic injuries in pet birds (Helmer and Redig, 2006) [10]. Falling during the first flight and trapping in the net were the major causes of musculoskeletal injury in wild birds and ceiling fan impaction was the most common cause of injury in birds kept in captivity (Kumar *et al.*, 2008) [11].

Ceiling fan infliction and road traffic accidents were the major etiological factors for wing fractures in birds (Sharma *et al.*, 2012) [12]. Falls and crushes in cages were the cause of fractures in birds raised in captivity whereas entanglement in electric cables, fences, wires, glass, road traffic accidents, and firearms were the cause of fractures in wild birds (Cherobini *et al.*, 2017) [13]. The primary aim of this retrospective analysis is to enhance our understanding of avian long-bone fractures and their causes. This will help to pave the way for improved veterinary care, conservation efforts, and the overall well-being of birds.

2. Materials and Methods

The study was conducted at the Orthopedic Outpatient Unit of Madras Veterinary College Teaching Hospital from October 2022 to October 2023 and analyzed 89 bird fracture cases. Incidence was collected based on the order of classification of birds, fractured limbs, fractured bone, location of fracture, age and causes of fracture. The data was analyzed and presented as a percentage.

3. Results

A total of 89 birds with long bone fractures were studied retrospectively. Out of a total of 89 cases, 35.96% (32 cases) involved fractures in the wing, while 64.04% (57 cases) were associated with pelvic limbs. The highest incidence of fractures occurred in the tibiotarsal region, accounting for 43.82% (39 cases), followed by the radius and ulna at 16.85% (15 cases), the humerus at 13.48% (12 cases), the femur at 13.48% (12 cases), the tars metatarsal at 6.74% (6 cases), and the lowest incidence was observed in the carpometacarpal region at 5.62% (5 cases) (Table-1). Among the 89 cases, 40.45% (36 cases) involved birds belonging to the order Psittaciformes, 31.46% (28 cases) involved birds from the order Galliformes, 19.10% (8 cases) involved birds under the order Columbiformes, and 8.99% (8 cases) involved birds from other orders like Strigiformes, Passeriformes and Pelecaniformes (Fig 1). Long bone fractures were categorized by location as proximal, mid-shaft, and distal. Based on the type of fracture, the cases were classified as transverse, oblique and comminuted. Among 89 cases, 61.80% (n=55) occurred in the midshaft, the most common site, followed by 25.84% (n=23) in the proximal aspect and 12.36% (n=11) in the distal third. Out of 89 cases, 49.44% (n=44) cases were oblique fractures, 44.49% (n=40) cases were transverse fractures and 5.62% (n=5) were comminuted fractures. In 43.82% (n=39) of tibiotarsal fractures, 25.84% (n=23) of cases were in the mid-shaft (Figure 3), the predominant site, 10.11% (n=9) in the proximal third, and 7.87% (n=7) in the distal third. 21.35% (n=19) cases were transverse fractures, 19.10% (n=17) were oblique and 3.37% (n=3) were comminuted fractures. Out of 16.85% (n=15) radius and ulna fractures, 11.24% (n=10) cases were in the midshaft, 4.49% (n=4) in the proximal third, and 1.12% (n=1) in the distal third. 10.11% (n=9) cases were transverse and 6.74% (n=6) cases were oblique. In 13.48% (n=12) of humerus fractures, the highest incidence was in the midshaft (8.99%, n=8), followed by the proximal third (3.37%, n=3) (Figure 4), and the distal third (1.12%, n=1). 8.99% (n=8) cases were oblique fractures, 3.37% (n=3) cases were transverse and 1.12% (n=1) cases were comminuted. Out of 13.48% (n=12) femur fractures, the highest incidence was in the midshaft (7.78%, n=7), followed by the proximal third (3.37%, n=3), and the distal third (2.25%, n=2). 8.99% (n=8) cases were oblique, 3.37% (n=3) cases were transverse and 1.12% (n=1) cases were comminuted. In Tars metatarsal fractures 6.74% (n=6), 2.25% (n=2) cases were in the proximal aspect and 4.49% (n=4) in the midshaft region. 4.49% (n=4) cases were transverse and 2.25% (n=2) cases were oblique. In carpometacarpal fractures 5.62% (n=5), 2.25% (n=2) cases were in the proximal third region and 3.37% (n=3) in the distal third region. 3.37% (n=3) cases were oblique and 2.25% (n=2) cases were transverse (Table 2 and Fig 2).

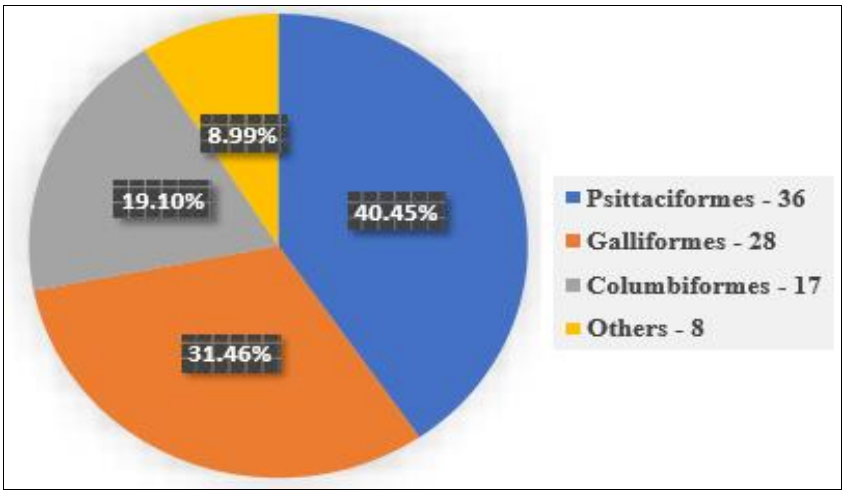

Fig 1: Classification of fractures cases based the order of birds

Table 1: Limb-wise and bone-wise incidence of long bone fractures in birds

Fractured Limb	Number	Percentage	Bones	Number	Percentage
Wing	32	35.96	Humerus	12	13.48
			Radius and Ulna	15	16.85
			Carpometacarpal	5	5.62
Pelvic limb	57	64.04	Femur	12	13.49
			Tibiotarsal	39	43.82
			Tars metatarsal	6	6.74
Total	89	100		89	100

Table 2: Location-wise incidence of long bone fractures in birds

Fractured bone	No of cases% (n)	Proximal% (n)	Mid-shaft% (n)	Distal% (n)
Humerus	13.48% (12)	3.37% (3)	8.99% (8)	1.12% (1)
Radius and Ulna	16.85% (15)	4.49% (4)	11.24% (10)	1.12% (1)
Carpometacarpal	5.62% (5)	2.25% (2)	3.37% (3)	-
Femur	13.49% (12)	3.37% (3)	7.87% (7)	2.25% (2)
Tibiotarsal	43.82% (39)	10.11% (9)	25.84% (23)	7.87% (7)
Tars metatarsal	6.74% (6)	2.25% (2)	4.49% (4)	-
Total	100% (89)	25.84% (23)	61.80% (55)	12.36% (11)

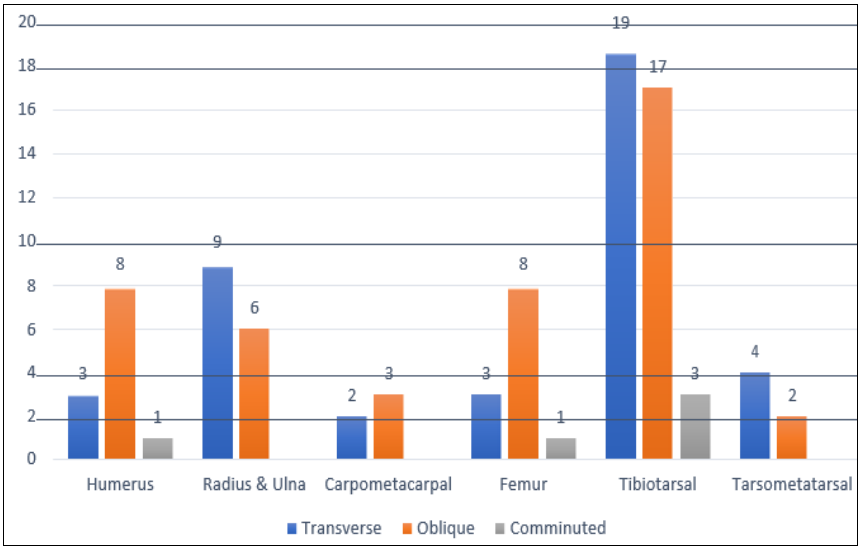

Fig 2: Incidence of different types of fracture in birds

In the present study, birds were grouped into 3 age groups as 0 to 6 months, 6 to 12 months and more than a year. The incidence of long bone fractures in 0 to 6 months was 11.24% (n=10), 6 to 12 months was 50.56% (n=45) and more than one year was 38.20% (n=34). In group 0-6 months (11.24%), the highest incidence of fracture was recorded in tibiotarsal 6.67% (n=6), followed by radius and ulna 3.37% (n=3) and humerus 1.12% (n=1). In group 6 to 12 month (50.56%), the highest incidence of fractures were in tibiotarsal 17.98% (16), followed by radius and ulna 10.11% (n=9), humerus 8.99% (n=8), femur 8.99% (n=8), tarsometatarsal 2.25% (n=2) and carpometacarpal 2.25% (n=2). In the group more than a year, the highest incidence was recorded in tibiotarsal 19.10% (n=170, followed by femur 4.49% (n=4), tarsometatarsal 4.9% (n=4), humerus 3.37% (n=3), radius and ulna 3.37% (n=3) and carpometacarpal 3.37% (n=3), (Fig 5).

Various causes of long bone fractures were recorded. The major causes were ceiling fan injury at 52.81 (n=47), followed by cage entrapment at 21.35% (n=19), unknown cause at 15.73% (n=14), man-made injury 6.74% (n=6) and Road accident 3.37% (n=3). Most of the tibiotarsal fractures (43.82%) are due to cage entrapment 15.73% (n=14), followed by fan injury 13.49% (n=12), unknown cause 7.87% (n=7), man-made injury 3.37% (n=3) and road accident 3.37%. The main causes for radius and ulna fracture (16.85) were fan injury 14.61% (n=13) and 2.25% (n=2) were unknown cause. In 13.48% of humerus fractures, 11.24% (n=10) were due to ceiling fan injury and 2.25% (n=2) were due to an unknown cause. Most of the femur fractures were due to fan injury 8.899% (n=8), followed by cage entrapment 2.25% (n=2) and man-made injury 2.25% (n=2). Causes for tarsometatarsal fractures were fan injury at 1.12% (n=1), cage entrapment at 3.37% (n=3), man-made injury at 1.12% (n=1) and unknown cause at 1.12% (n=1). The cause of carpometacarpal fractures was fan injury at 3.37% (n=3) and unknown causes at 2.25% (n=2), (Table 3).

Fig 3: Oblique Midshaft tibiotarsal fracture

Fig 4: Comminuted proximal Humerus fracture

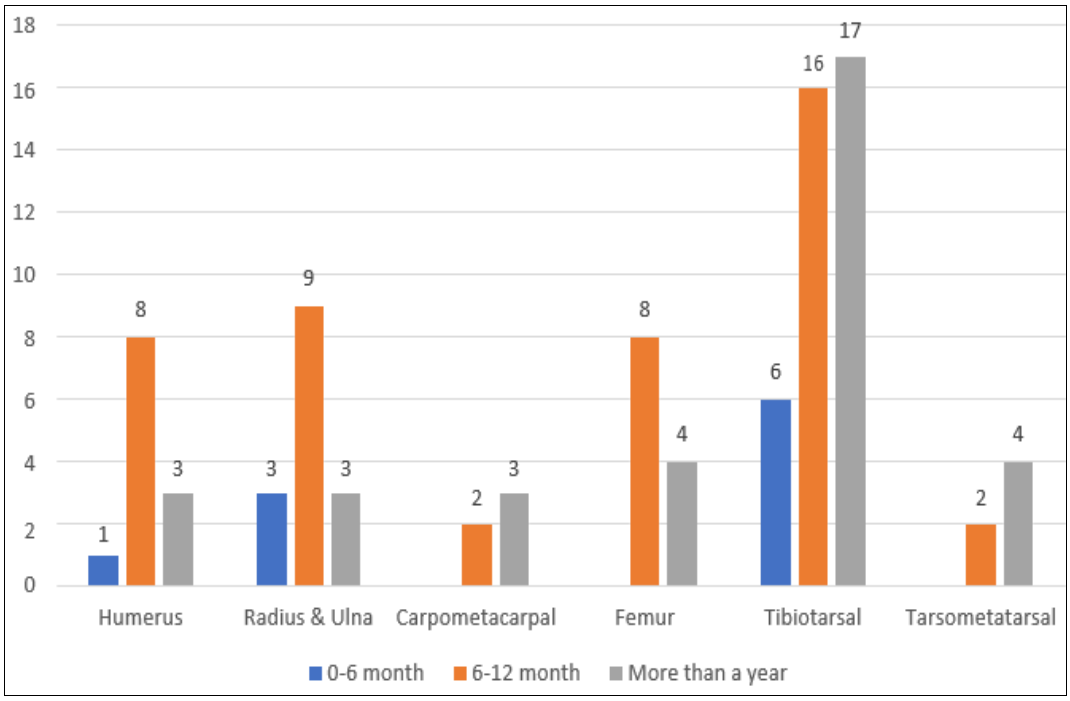

Fig 5: Age-wise incidence of long bone fractures in birds

Table 3: Incidence of long bone fractures based on etiology

Fractured bone	No of cases % (n)	Ceiling Fan injury % (n)	Cage entrapment % (n)	Man-made injury % (n)	Road Accident % (n)	Unknown % (n)
Humerus	13.48% (12)	11.24% (10)	-	-	-	2.25% (2)
Radius and Ulna	16.85% (15)	14.61% (13)	-	-	-	2.25% (2)
Carpometacarpal	5.62% (5)	3.37% (3)	-	-	-	2.25% (2)
Femur	13.49%	8.99%	2.25% (2)	2.25%	-	-
	(12)	(8)		(2)		
Tibiotarsal	43.82%	13.49%	15.73% (14)	3.37%	3.37%	7.87% (7)
	(39)	(12)		(3)	(3)	
Tars metatarsal	6.74% (6)	1.12%	3.37% (3)	1.12%	-	1.12% (1)
		(1)		(1)		
Total	100% (89)	52.81%	21.35% (19)	6.74%	3.37%	15.73%
		(47)		(6)	(3)	(14)

4. Discussion

In this study incidence of pelvic limb fracture (64.04%) was more compared to wing fracture (35.96%). Because most of the birds included in this study were cage-reared and companion birds. Similarly, Arnall *et al.* (1975) [3] and Islam *et al.* (2002) [4] stated that leg fractures were more common in cage-rearing birds than wing fractures. Tibiotarsal fractures (43.82%) were commonly affected and the reason may be due to long and more exposure of the bone (Arias *et al.*, 2015) [14] and the radius and ulna (16.85%) were the second most commonly affected bone in this study. The tibiotarsal and radius and ulna bones exhibited lower muscle protection in comparison to the femur and humerus, rendering them more prone to fractures. Our study was similar to Westfall and Egger (1979) [15] who stated that tibiotarsal and tars metatarsal fractures account for 65% of overall fractures in canaries and budgerigars. The causes of tibiotarsal fractures in companion bird practice were mainly due to mishandling, cage-related trauma, and injuries caused by other pets (Harcourt-Brown, 2002; Rosskopf 2003, Eshar and Briscoe, 2009, Wright *et al.*, 2018) [5-8].

This study had a higher incidence of Psittaciformes birds (40.45%) cases. The study was conducted in an urban area setting where a growing trend among city residents involves adopting birds as companions. Cockatiels, Macaw, Conure, budgerigars, cockatoos, and lorikeets were the commonly reported avian companions in this study, predominantly from the Psittaciformes order. Anatomical characteristics, poor-quality diet, poor ultraviolet exposure, low activity levels, osteomyelitis, neoplasia, and trauma predisposed to fractures in captive birds (Jalilpour *et al.*, 2020) [16]. Improper handling, poor management of cage and aviary, and poor nutrition were reasons for the high incidence of fractures among pet birds in this study. Owners should create a safe and bird-friendly environment to minimize the risk of accidents. This includes removing potential hazards, securing windows, ceiling fans and doors, and providing a secure cage or aviary.

The incidence of midshaft fracture (61.80) was the highest in all the bones followed by proximal 3rd (25.84%) and oblique fractures (49.44%) accounted for more followed by transverse fractures (44.49%). According to MacCoy (1992) [17], fractures near joints have a poor prognosis due to the risk of damaging cartilage and support structures, while midshaft fractures are more easily stabilized. Proximal and midshaft tibiotarsal fractures have a good prognosis for healing. The bones of birds are characterized by a thin cortex and a system of internal struts or trabecular that provide structural support. While these adaptations are beneficial for reducing weight and aiding in flight, they also make avian bones more fragile and susceptible to fractures. The thin and brittle nature of

avian bones can lead to transverse or oblique fractures, especially under the high forces and impact stresses experienced during flight, landing, or other activities.

The incidence of fracture is more common among the age group between 6 to 12 months of age (50.56%). Due to the hyperactivity of this age group birds, accidental falls, mishandling and poor-quality diets may be the reason for the highest incidence of fracture. Ceiling fan injury (52.81%) and cage entrapment (21.35%) were the common etiology for fractures in this study ((Sharma *et al.*, 2012, Kumar *et al.*, 2008, Cherobini *et al.*, 2017) [12, 11, 13]. Most of the collision with ceiling fans cases were presented along with the internal injury and initial stabilization was warranted for those cases. Most of the internal injury cases have a poor prognosis.

The prognosis of most of the open fractures was poor due to extensive soft tissue damage, blood vessel impairment, and contamination. In many instances, open fractures resulted in the eventual amputation of the affected limb. Leg fractures generally had a more favorable prognosis when compared with wing fractures. The wings, unfortunately, became less functional due to an excessive formation of callus and malalignment.

5. Conclusion

This study revealed a higher incidence of pelvic limb fractures compared to wing fractures, with a notable prevalence among companion birds. Ceiling fan injuries emerged as a primary cause of fractures in companion birds. Tibiotarsal bone fractures were more frequent in pelvic limb cases, while wing fractures predominantly involved the radius and ulna. This study emphasizes the need for preventive care to reduce the risk of fractures in companion birds.

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