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ORIGINAL ARTICLE

Prevalence and Pattern of Non-Trauma Induced Bone Disorders Among Young Dogs Presented At The Veterinary Teaching Hospital, University Of Ibadan, Nigeria

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SUMMARY

The study evaluated the prevalence and pattern of orthopaedic conditions in young dogs below one year presented at the Veterinary Teaching Hospital, University of Ibadan Nigeria from January 2015 to April 2019. Out of two hundred and thirty-eight (238) patients presented for surgical management, fifty-one cases (21%) were orthopaedic in nature, and thirty-two cases (62.7%) involved young dogs below 1-year-old. Seventy-five percent (75 %) were males while 25 % were female. Fifty percent of young dogs presenting with fracture had no apparent bone disorders. Some (15.6%) had Legg-Calve Perthes disease (LCPD) with or without fracture**.** While 12.5% had Osteopenia with or without fracture. Other observed bone disorders included: hypertrophic osteodystrophy with or without fracture (6.3%), osteochondrosis (6.3%), and hyperostosis (3.1%). Fifty percent of fractures occurred on the tibia and fibula, 31% occurred on the femur, 13% were on the radius and ulna, and 6% were on the humerus. The bones of most of the patients were low in radiographic opacity, presenting with thin cortical margins and enlarged medullary cavity, with resultant low cortical bone index. The mean cortical bone index for the femur was 0.107 ± 0.04, and tibia was 0.09 ± 0.04. Those of humerus and radio-ulna were not included for low case numbers. We therefore conclude that bones disorders, with or without fracture, are common in young dogs presenting lameness in Ibadan, Nigeria, and should be noted during patient routine examination, and pet-owners counselling on pets' care for proper bone health.

Key words: Non-traumatic, Bone disease, Fracture, Young dogs

INTRODUCTION

Orthopaedic conditions in pet animals (dogs and cats) constitute a high percentage of surgery patients' caseload in veterinary clinics and hospitals in different parts of the world (Peirmattei *et al*., 2006; Scott and McLaughlin,

2008; Simon, *et al*., 2010; Ali, 2013; Singh, *et al*., 2015), including Nigeria (Adeyanju *et al*., 1988; Adeyanju *et al*., 2004; Akinrinmade, 2014; Eyarefe and Oyetayo, 2016). Among arrays of orthopaedic conditions, fracture ranked highest in dogs than cats (Bennour *et al*., 2014; Singh *et al*., 2015), with femoral fractures presenting the most in dogs than bitches, and in puppies (<1 year) than adult dogs (Simon, *et al*., 2010; Adeyanju *et al*., 2004; Ali, 2013; Eyarefe and Oyetayo, 2016). Most fracture conditions are associated with trauma (Libardoni *et al*., 2016; Akinrinmade, 2014), with automobile accident and falling from height ranking highest among aetiological factors (Newton, 1985: Ali, 2013). In recent times, there has been an upsurge of non-trauma associated orthopaedic disorders among young dogs presented at the Veterinary Teaching Hospital at the University of Ibadan with affected bones presenting with decreased radiopacity, thin cortexes and enlarged medullary cavities. Others had developmental and congenital disorders that included: hypertrophic osteodystrophy, Legg-Calve Perthes disease (Calve, 1910) with concomitant patient lameness of varying degrees. Although, literature is replete with classification of bone disorders, especially fractures in dogs generally, there is a dearth of information on the prevalence and pattern of non-traumatic orthopaedic disorders secondary to nutrition (Aithal *et al*., 1999), bone pathology and hormonal derangement (Alexander, 1985; Capen, 1985) especially in young dogs in Nigeria. This is important and noteworthy as we witness an increase in large dogs' breeds acquisition and breeding activities associated with security concerns in Nigeria (Eyarefe and Oyetayo, 2016; Eyarefe and Adetunji, 2018). This study, therefore, investigated the prevalence and pattern of bone disorders in puppies (dogs less than 1 year) with the objective of reporting the burden of non-traumatic orthopaedic disease pattern among this age group in Nigeria. The result of the study could provide fundamental data on the prevalence of bone pathology among young dogs that could serve for paediatric patient management, and pet owners counselling criteria on bone health.

MATERIALS AND METHODS

Study Population: Case records of surgery patients managed between 2015 and 2019 were studied. All cases of young animal (less than 1-year - old) presented with lameness due to fracture and other non-trauma bone pathology were included.

Demographic capture: Their demographic information (breed, age, sex, and body weight), fracture causation, bone pathology and anatomic location were captured.

Radiographic evaluation: Each patient's case records were reconciled with obtained radiographs and studied.

Radiographic bone morphometry: Appendicular bones cortices (Femur, Tibia, Radio-ulna or Humerus) and medullary cavity dimensions were determined using a medical and statistical software for image analysis (Digimizer^{R}, Med.Calc. software, Belgium). Each measurement was taken at mid-diaphysis of the bone as previously described (Jennings *et al*., 2016; Kumar *et al*., 2009) in pixel and converted to millimetres (1 Pixel =0.2645833333 mm) (Unit Converters. net, 2019). The Cortical thickness and Cortical index were calculated using the formula Cortical Thickness $(CT) =$

$\frac{BD-MCD}{2}$, and Cortical Thickness Index $(CTI) = \frac{BD-MCD}{BD}$ respectively, where BD is Bone Diameter, and MCD is the Medullary Cavity Dimension (Jennings *et al*., 2016).

Data Analysis: The data were organized and the mean and standard deviation determined using the Statistical Package for Social Science (SPSS) for Windows Version 22 and presented with descriptive statistics.

RESULT

Number of surgical Patients: Two hundred and thirty-eight (238) patients were presented for surgery within the study period (January 2015 and April 2019), out of which fifty-one cases (21%) were orthopaedic in nature. Thirty-two cases (62.7%) involved young animals below 1 year.

Sex distribution of young dog with bone disorders: Seventy-five percent were dogs while 25 % were bitches. (Figure1).

Categories of bone disorders: Fifty percent of young dogs presenting with fracture had no apparent bone disorders. Some puppies (15.6%) had Legg-Calve Perthes disease (LCPD) with or without fracture; while 12.5% of the puppies had osteopenia with or without fracture. Osteodystrophy with or without fracture was 6.3%. Other observed bone disorders include: Osteochondrosis (6.3%), and hyperostosis (3.1%). (Table 1; Figure 3 - 7).

Distribution of anatomical location of fracture among the young dogs studied: Fifty percent of fractures occurred on the tibia and fibula bones, 31% occurred on the femur, 13 % were on the radius and ulna and 6% were on the humerus (Figure 2).

TABLE I: Showing records of young dogs with bone disease conditions

S/N	CATEGORY	NUMBER OF CASES	Percentage (%)
1	Osteodystrophy with or without fracture	4	12.5
2	Legg-Calve Perthes disease (LCPD) with or without fracture	5	15.6
3	Osteopenia with or without fracture	4	12.5
4	Osteochondrosis	2	6.3
5	Hyperostosis	1	3.1
6	Fractures alone (without apparent disease conditions)	16	50
	TOTAL	32	100

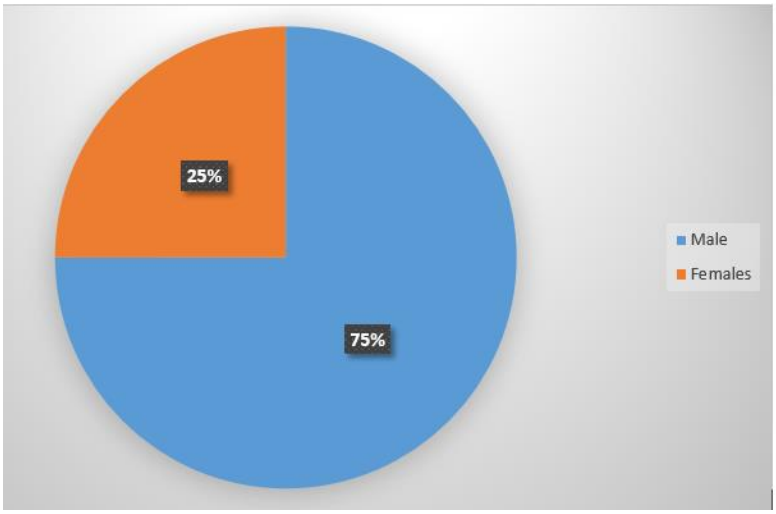

FIGURE 1: Showing sex distribution of young dogs with varying orthopaedic conditions

Radiographic and bone morphometric evaluations: Bones of most of the patients had low radiopacity and presented with thin cortical margins, enlarged medullary cavity dimensions, and low cortical bone index. The Mean cortical bone index for the femur was 0.107±0.04, and tibia was 0.09 ± 0.04. The cortical bone indexes for the humerus and radio-ulna were not included for low case numbers (humerus (1) and radio-ulna (2). (Table 2, 3, figure 4 and 6).

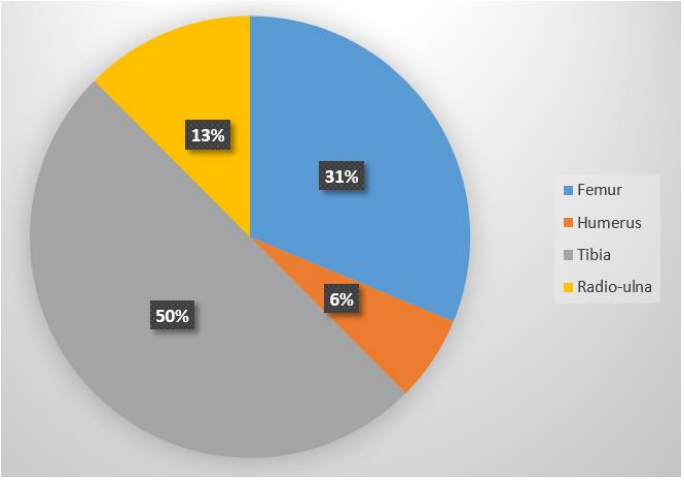

FIGURE II: Showing distribution of anatomic location of fractures among dogs presented with varying bone disease conditions

FIGURE III: A case of hypertrophic osteodystrophy with degenerative elbow joint in a 7-month-old Boerboel dog. Note the detached ulna, the curved radio-ulna bones and distal epiphysis of

FIGURE IV: Showing a case of bilateral femoral fracture induced by nutritional osteopenia in a 3-month-old male Boerboel. Note the thin cortices and the relatively large medullary cavities of the femur and tibia bones.

FIGURE V: Showing a case of bilateral femoral fracture induced by nutritional osteopenia in a 3-month-old male Boerboel. Note the thin cortices and the relatively large medullary cavities of the femur and tibia bones.

FIGURE VI: Showing a case of nutritional osteopenia in a 4-month-old male Rottweiler breed. Note the secondary fracture at the distal metaphysis of the femur (Arrow) due to apparent weakness and fragility of the bone.

FIGURE VII: Showing a case of nutritional osteopenia in a 4-month-old male Rottweiler breed. Note the secondary fracture at the distal metaphysis of the femur (Arrow) due to apparent weakness and fragility of the bone.

TABLE II: Showing cortex and medullary cavity dimensions of femoral bones in the dogs studied with varying degrees of osteopoenia

S/N	Medullary Cavity Dimension (MCD) (mm)	Bone Diameter (BD) (mm)	Cortical Thickness (CT) (mm)	Cortical Thickness Index (CTI) (mm)
1	5.599	8.754	1.577	0.095
2	6.236	10.512	2.138	0.108
3	18.682	23.343	2.330	0.053
4	13.985	18.853	2.434	0.068
5	8.399	17.538	4.569	0.138
6	6.624	16.048	4.712	0.155
7	11.543	22.991	5.724	0.132
Mean	**10.153**	**16.863**	**3.355**	**0.107**
Std Dev	**±4.85**	**±5.63**	**±1.60**	**±0.04**

$$\textbf{\textit{C}}\text{ortical Thickness (CT)} = \frac{\text{BD} - \text{MCD}}{2}$$

$$\textbf{\textit{C}}\text{ortical Thickness Index (CTI)}$$

DISCUSSION

The result of this study shows a prevalence of non-traumatic bone disorders among young dogs presented with lameness at the Veterinary Teaching Hospital (VTH) at the University of Ibadan. In recent times, there has been an increase in acquisition and breeding activities of dogs, especially the larger breeds due to security and companionship (Eyarefe and Adetunji, 2018). In most cases dogs' owners and breeders do not source for the nutritional requirement for bone health, neither are they prepared for the financial demand for the animal's care. In a particular case, the patient had multiple fractures without history of trauma (Personal experience). The observation

TABLE III: Showing cortex and medullary cavity dimensions of Tibia bones in the dogs studied with varying degrees of osteopenia

S/N	Medullary Cavity Dimension (MCD) (mm)	Bone Diameter (BD) (mm)	Cortical Thickness (CT) (mm)	Cortical Thickness Index (CTI) (mm)
1	5.599	8.754	1.577	0.095
2	6.526	10.516	1.995	0.162
3	11.278	24.279	6.501	0.142
4	12.069	17.969	2.949	0.0868
5	13.122	19.215	3.046	0.084
6	14.815	22.332	3.758	0.089
7	15.432	22.899	3.734	0.087
8	15.587	21.565	2.989	0.073
9	20.668	27.059	3.196	0.062
10	22.694	27.528	2.417	0.047
Mean	**13.779**	**20.212**	**3.216**	**0.093**
Std Dev	**±5.407**	**±6.341**	**±1.347**	**±0.035**

TABLE IV: Showing cortex and medullary cavity dimensions of Radio-ulna bones in dogs studied with varying degrees of osteopoenia.

S/N	Medullary Cavity Dimension (MCD) (mm)	Bone Diameter (BD) (mm)	Cortical Thickness (CT) (mm)	Cortical Thickness Index (CTI) (mm)
1	15.437	0.265	5.119	0.106
2	24.368	27.249	1.441	0.028
Mean	**19.903**	**13.757**	**3.280**	**0.067**
Std Dev	**±6.315**	**±19.081**	**±2.601**	**±0.055**

in this study may represent the situation in veterinary clinics and hospitals across the country. The VTH, University of Ibadan, is a leading veterinary health centre in south-west Nigeria, and attracts referral, including orthopaedic cases from other veterinary clinics and hospitals in the region (Eyarefe and Oyetayo, 2016; Eyarefe and Adetunji, 2018; Van Niekerk, 2002)

In this study, the primary cause of 50% of fracture cases was trauma with a higher prepondance cases among young dogs (Simon, *et al*., 2010; Ali, 2013, Singh, *et al*., 2015. Young dogs have higher incidence of fractures due to their naivety to avoiding danger, and their relatively poor psychosocial adjustment to their environment compared with adult dogs (Ali, 2013; Singh, *et al*., 2015). In Nigeria, road traffic accident, falling from height and hit with a hard object are the major causes of fracture among younger dogs (Adeyanju *et al*., 1988; Adeyanju *et al*., 2004; Akinrinmade, 2014).

Fifty percent of the orthopaedic disorders observed in this study were associated with non-traumatic bone disorders (osteopenia, osteodystrophy, Legg-Calve-Parthes disease, and hyperostosis), with higher prevalence in males than in females, which could be as a result of less oestrogen in males than females, making their bones more brittle as previously reported (Aithal *et al*., 1999). These conditions, which have been previously reported to be primarily nutritional and secondarily metabolic in nature, were associated with low dietary protein, calorie, vitamin D, calcium, dietary calcium-phosphorus imbalances, and trace minerals deficiencies (Bennet, 1976; Woodard and Wayne 1993; Abeles, *et al*., 1999; Pye., *et al.,* 2013). Balanced nutrition is extremely important for bone development and total wellbeing of the dog (Dammrich, 1991). Malnutrition especially in puppies has been associated with defective bone development, especially those of large dog breeds (Dammrich, 1991; Dodd, *et al*., 2019). There is dearth of literature regarding the exact normal and abnormal values of cortex and medullary cavity dimensions to establish osteopenia. Osteopenia was therefore established by decreased radiopacity, thin bone cortex, and expanded medullary cavity. These were prevalent among the young dogs studied. In a similar report, bones of puppies were characterized by decrease in cortical density, thin cortices and widened metaphyses/epiphyses (Aithal, *et al*., 1999; Kumar *et al.*, 2009). These bone radiographic characteristics were also observed in juvenile Koalas (*Phascolarctos cinereus*) diagnosed with metabolic bone diseases (Pye, *et al.*, 2013). In a report by Dodd *et al.*, 2019, severe osteopenia and marked dietary deficiency (calcium, phosphorus, and vitamin D deficiency) were observed in a 4-month-old English sheepdog fed with a raw meat home-made diet and presenting with lameness. In this study, thinner bone cortices with low cortical index were more pronounced in dogs' femur and tibia bones. These porotic bones with thin and weak cortices, often reduce the surgeons' choices of fixatives for fracture management, due to the bone's low potentials at holding fixatives and concomitant healing complications (Fossum *et al.*, 2002). Hypertrophic osteodystrophy (canine scurvy) was observed in some of the young dogs. This condition occurs in young dogs between 3 – 4 months, with preponderance in male dogs than bitches (Lenehan, *et al*., 1985, Abeles *et al*., 1999). This condition has also been diagnosed in cats (Yurdakul and Bakir, 2017). The aetiology

and pathogenesis of Hypertrophic osteodystrophy (HOD) is still controversial, however, hypovitaminosis C has been suggested as a potential cause, or a contributing factor to the disease (Bellah, 1993). In most of these cases, administration of quality commercial puppy diet aided the correction of observed bone abnormality and a return of patient limbs' functions, which has corroborated previous reports for the need to feed puppies with balanced quality commercial diet rather than home-made diet fraught with faulty nutritional compositions (Dammrich, 1991; Dodd *et al.*, 2019).

Legg-Calve Parthes disease was less-common in this report (5 cases). This condition results from metabolic and hormonal imbalances, heredity, infection and vascular abnormalities (Ljunggren, *et al.*, 1967, Paatsame, *et al.*, 1968). Most cases do progress to severe osteoarthrosis with a possibility of 25% recovery from lameness following conservative management (rest, limited exercise, analgesia and good nutrition). Excision arthroplasty has been recommended with 84% – 100% success rate (Warren and Dingwall, 1972).

In conclusion, bone disorders with or without fracture, are common in young dogs presenting lameness in Nigeria, and this should be evaluated for management, and pet-owners counselling on pets' nutritional care for proper bone health.

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