



Contribution of radiography to the diagnosis of musculoskeletal disorders in dogs at the Veterinary Center of the Lubumbashi Zoo

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ABSTRACT

Objective: This study aimed to evaluate the quantitative and qualitative contribution of digital radiography to the diagnosis of musculoskeletal disorders in dogs at the Veterinary Center of the Lubumbashi Zoological Garden, with a view to improving the quality of canine medical care in Lubumbashi.

Methodology and Results: A prospective and retrospective study was conducted on radiographic examinations performed on animals presented for consultation. Data were collected from clinical records, registers and archived radiographs. A total of 202 radiographs were analyzed, including 103 (50.9%) concerning dogs. Most examinations (71.8%) were requested by attending veterinarians. Of the 202 radiographs, 197 (97.5%) were compliant, and 137 (69.5%) provided diagnostic information, demonstrating the effectiveness of digital image development. Dogs over 24 months of age and males were the most represented. Various local and exotic breeds were involved, with crossbreeds and Boer Boël being among the most frequently radiographed. The girdle and pelvic limbs (55.3%) were the most examined anatomical regions, particularly the pelvis and thigh, followed by the girdle and thoracic limbs (34.2%). The lumbar and sacral regions were the most affected portions of the spine. Radiographic findings included multiple pelvic fractures, femoral fractures, tibia-fibula fractures, vertebral fractures, hip dysplasia, and osteosarcoma.

Conclusion and Application of Results: Digital radiography proved to be an essential diagnostic tool in the evaluation of musculoskeletal disorders in dogs. It significantly improved image quality and diagnostic accuracy while reducing non-diagnostic examinations. Its wider implementation in veterinary practice in Lubumbashi would enhance early detection of lesions, guide appropriate therapeutic decisions, and ultimately improve canine health management. Clinical symptoms represented only by lameness and local swellings often call for reservations when establishing a precise diagnosis. However, an accurate diagnosis is not always possible with the elements of clinical diagnosis at the disposal of the veterinarian. In view of these limitations, there is a need to resort to the veterinary laboratory to make a definitive diagnosis. X-ray is a complementary

examination frequently performed for all types of consultation (musculoskeletal, cardiology, digestive, respiratory, urinary pathology, reproductive system,).

INTRODUCTION

The dog has an important place in society; providing companionship, security and leisure in human life. Due to its socio-economic importance, its health is a major concern in society. The quality of care the dog enjoys must be of great importance due to its proximity to humans. Thrall and Robertson, (2022). stated that dogs, like any other animals, have the right to life, respect, health care and protection. This implies that it is likely to develop several pathologies (Burk and Feeney, 2021). In canine clinics, veterinary practitioners encounter fractures on a daily basis, mainly due to traffic accidents (Dennis *et al.* 2021). According to Fossum (2022), the precise diagnosis of limb lesions has always been challenging. Clinical symptoms represented only by lameness and local swellings often call for reservations when establishing a precise diagnosis, instrument of an adequate therapy. However, an accurate diagnosis is not always possible with the elements of clinical diagnosis at the disposal of the veterinarian. In view of these limitations with catastrophic consequences, there is a need to resort to the veterinary laboratory (or other competent centres) to make a definitive diagnosis. Kinns (2020) stipulate that an x-ray is a complementary examination frequently performed for all types of consultation (musculoskeletal, cardiology, digestive, respiratory, urinary pathology, reproductive system,.) but a new radiological scanner or

MATERIALS AND METHODS

The veterinary centre is located within the Lubumbashi Zoological Garden which is situated at N° 1 at the corner of Boulevard Karmayloa and Route Kipushi, in the Lido-Golf district in the commune of Lubumbashi, Haut-Katanga Province, in the Democratic Republic of Congo. The Lubumbashi zoo

digital development offer the possibility of obtaining high quality images in short period of time than when developing a film image. The aforementioned author adds, affirming that in recent years digital development has revealed itself to be a precise diagnostic tool in the care of animals. According to Bennett and May (2023), the use of imaging equipment is dramatic in Africa. Devices are scarce and often out of service. Accessibility to this tool is not at all easy given the high cost of exams. And yet, para-clinical examinations have their place of choice in the practice of modern veterinary medicine despite their non-existence among Congolese veterinarians. The latter are not always motivated to use it for an adequate diagnosis leading to a judicious treatment (Gemmill, 2021). From the above, the problem of this study revolves around two questions below:

- Is radiography really useful in the practice of the veterinary profession in Lubumbashi?
- What is the merit of digital development in the diagnosis of lesions of the musculoskeletal system in canine clinics?

The general objective of this study is to improve the quality of care provided to dogs in the city of Lubumbashi.

Specifically, this work aims to evaluate the quantitative and qualitative contributions of digital development to the diagnosis of musculoskeletal disorders in dogs.

extends over an area of 30 ha; it is limited to the East by Boulevard Kamanyola, to the West by Avenue Ngongo Lutete, to the North by Avenue Ruwe and to the South by Kipushi Road.

GPS coordinates:

- Latitude : S 11°40'16.572"
- Longitude : E 27°28'32.679"

Animals: This research is the product of an investigation on the lesions of the musculoskeletal system in the following breeds of canine species "Dogs": Great Dane, German Shepherd, Belgian Shepherd, Bichon, Boer Boël, Boston terrier, Bull dog, American Bully, Chihuahua, Cocker Spaniel, Collie, Crossbreed, Fox Terrier, Jack Russell, Labrador, Mini Loulou, Pit bull, Ridgeback, Rottweiler, Dachshund and York shire.

Methods: The animals were brought for consultation by their respective owners, people familiar with them or attending veterinarian. Information on patient data identification and anamnesis were electronically captured (clinical form). Animals were restrained for general clinical examination and clinical data collection. Any complaint or request from the

owner, any suspicion, any symptom, any injury related to the musculoskeletal system resorted to the radiographic examination for a confirmation diagnosis. The same was true during operations involving the musculoskeletal system. The radiographs done on the musculoskeletal system in dogs were selected then distributed according to gender, age, conformity criterion and parts of the musculoskeletal system, and finally analysed with a view to establishing the radiographic diagnosis. Animals were restrained, rationally exposed to X-rays for radiographs. Films were thereafter developed by digital method and reading was done on the computer. During the bombardment, protective devices against the biological effects of X-rays were rigorously applied. In order to cover the entire period of our study, data shortage was compensated by the retrospective method done from the archives (registers and photographs).

RESULTS

The data relate to the number and distribution of radiographs performed according to species, according to the conformity of radiographs and according to the presence or lack of diagnostic information are presented in the tables 1,2 and 3 below. The data from this study also relate to the number and distribution of x-rays of dogs according to age categories, gender, breeds, parts of the musculoskeletal system, regions of each of these.

Number and distribution of x-rays: Data relating to the number and distribution of radiographs taken according to species, according to the conformity of the images and according to the presence or absence of diagnostic information, presented successively in tables 1, 2 and 3. The canine species are included in the tables numbered 4 to 19.

Table 1: Number of X-rays according to reasons and animal species (n=202).

Motif	Cat		Dog		Chimpanzee		Horse		Total	
	ni	%	ni	%	n	%	ni	%	ni	%
Request from owners	7	3.5	29	14.4	10	5.0	11	5.4	57	28.2
Request from treating veterinarians	12	5.9	74	36.6	42	20.8	17	8.4	145	71.8
Total	19	9.4	103	51.0	52	25.7	28	13.9	202	100

Legend: ni = absolute frequency, % = relative frequency.

Observations from this table indicate that most of x-rays from different animal species were a recommendation from attending

veterinarians than the request from the owners.

Table 2: Number of compliant and non-compliant radiographs according to animal species (n=202).

Radiographies	Cat		Dog		Chimpanzee		Horse		Total	
	ni	%	ni	%	n	%	ni	%	ni	%
Non-compliant	0	0.0	4	2.0	0	0.0	1	0.4	5	2.5
Compliant	19	9.4	99	49.0	52	25.7	27	13.3	197	97.5
Total	19	9.4	103	51.0	52	25.7	28	13.7	202	100

Legend: ni = absolute frequency, % = relative frequency

Table n°2 shows that the number of compliant radiographs is greater than that of non-compliant radiographs in all animal species.

Table 3: Number of radiographs with or lacking diagnostic information according to animal species (n=197).

Lesions	Cat		Dog		Chimpanzee		Horse		total	
	ni	%	ni	%	n	%	ni	%	ni	%
Information (+)	17	8.6	43	21.8	50	25.4	27	13.7	137	69.5
Information (-)	2	1.0	56	56.5	2	1.0	0	0.0	60	30.5
Total	19	9.6	99	50.2	52	26.4	27	13.7	197	100

Legend: ni = absolute frequency, % = relative frequency.

The table above reveals that 69.5% of species had diagnostic information, excluding radiographic images from various animal canine species.

Distribution of x-rays from dogs.

Table 4: Distribution of X-rays from dogs according to age and gender (n=103).

Catégories d'âge	Males		Females		Total	
	ni	%	ni	%	ni	%
From 1 to 6 moths	17	16.5	6	5.8	23	22.3
From 7 to 24 moths	19	18.4	11	10.7	30	29.1
Above 24 moths	28	27.1	22	21.3	50	48.5
Total	64	62.1	39	37.9	103	100

Legend: ni = absolute frequency, % = relative frequency.

Dogs aged above 24 months from both genders were the most x-rayed.

Table 5: Distribution of X-rays by breed and gender (n=103).

Breed	Males		Females		Total	
	ni	%	ni	%	ni	%
German Shepherd	7	6.8	2	1.9	9	8.7
Belgian Shepherd	1	1.0	1	1.0	2	1.9
Bichon	3	2.9	3	2.9	6	5.8
Boer Boël	8	7.8	5	4.9	13	12.6
Boston terrier	2	1.9	0	0.0	2	1.9
American Bully	0	0.0	1	1.0	1	1.0
Bull dog	0	0.0	2	1.9	2	1.9
Chihuahua	0	0.0	2	1.9	2	1.9
Cocker	0	0.0	3	2.9	3	2.9
Collie	1	1.0	1	1.0	2	1.9
Crossbreeds	15	14.6	8	7.8	23	22.3
German Mastiff	3	2.9	1	1.0	4	3.9
Fox terrier	1	1.0	0	0.0	1	1.0
Jack Russel	5	4.9	2	1.9	7	6.8
Labrador	4	3.9	2	1.9	6	5.8
Mini loulou	0	0.0	1	1.0	1	1.0
Pit bull	1	1.0	1	1.0	2	1.9
Ridgeback	2	1.9	1	1.0	3	2.9
Rottweiler	3	2.9	4	3.9	7	6.8
Teckel	2	1.9	3	2.9	5	4.9
Yorkshire	0	0.0	2	1.9	2	1.9
Total	58	56.3	45	43.7	103	100

Legend: ni = absolute frequency, % = relative frequency.

According to the table above, among the dogs subjected to x-rays there were both genders and various local and exotic breeds.

Table 6: Distribution of X-rays according to breed and age group (n=103).

Breeds	From 0 to 6 moths		From 7 to 24 moths		Above 24 moths		Total	
	ni	%	ni	%	ni	%	ni	%
Berge allemand	2	1.9	3	2.9	4	3.9	9	8.7
Berger belge	0	0.0	2	1.9	0	0.0	2	1.9
Bichon	3	2.9	2	1.9	1	1.0	6	5.8
Boer Boël	5	4.9	4	3.9	4	4.9	13	12.6
Boston terrier	0	0.0	1	1.0	1	1.0	2	1.9
American Bully	0	0.0	1	1.0	0	0.0	1	1.0
Bull dog	0	0.0	2	1.9	0	0.0	2	1.9
Chihuahua	0	0.0	1	1.0	1	1.0	2	1.9
Cocker	0	0.0	0	0.0	3	2.9	3	2.3
Collie	0	0.0	0	0.0	2	1.9	2	1.9
Crossbreeds	5	4.9	10	9.7	8	7.8	23	22.3

German Mastiff	2	1.9	0	0.0	2	1.9	4	3.9
Fox terrier	0	0.0	0	0.0	1	1.0	1	1.0
Jack Russel	0	0.0	1	1.0	6	5.8	7	6.8
Labrador	1	1.0	2	1.9	3	2.9	6	5.8
Mini loulou	0	0.0	0	0.0	1	1.0	1	1.0
Pet bull	0	0.0	1	1.0	1	1.0	2	1.9
Ridgeback	1	1.0	1	1.0	1	1.0	3	2.9
Rottweiler	1	1.0	0	0.0	6	5.8	7	6.8
Teckel	1	1.0	1	1.0	3	2.9	5	4.9
Yorkshire	0	0.0	2	1.9	0	0.0	2	1.9
Total	21	20.4	34	33.0	48	46.6	103	100

Legend: ni = absolute frequency, % = relative frequency.

Data from table n°6 reveals that dogs aged over 6 months are associated with various crossbreeds (22.3%) followed by those belonging to the Boer Boël breed (12.6%).

Table 7: Distribution of dog X-rays according to parts of the musculoskeletal system and according to sexes (n=76).

Parts	Males		Females		Total	
	ni	%	ni	%	ni	%
Spine	2	2.6	6	7.9	8	10.5
Girdle and thoracic limbs	15	14.6	11	14.5	26	34.2
Girdle and pelvic limbs	23	30.3	19	25.0	42	55.3
Total	40	47.5	36	47.4	76	100

Legend: ni = absolute frequency, % = relative frequency.

According to the gender, Table n°7 displays that males were the most affected among the x-rays animals.

Table 8: Distribution of dog X-rays according to parts of the musculoskeletal system and according to age groups (n=76).

Parts	From 0 to 6 moths		From 7 to 24 moths		Above 24 moths		Total	
	ni	%	ni	%	ni	%	ni	%
Spine	0	0.0	1	1.3	7	9.2	8	10.5
Girdle and thoracic limbs	1	1.3	10	13.1	15	19.7	26	34.2
Girdle and pelvic limbs	13	17.1	17	22.4	12	15.8	42	55.3
Total	14	18.4	28	36.8	34	44.7	76	100

Legend: ni = absolute frequency, % = relative frequency.

Observations from table n°8 portray dogs above 2 years and those from 7 months to 24 months age group as the most x-rayed.

Tableau 9: Distribution of dog X-rays according to parts of the musculoskeletal system and according to the breed (n=76).

Breeds	Spine		Girdle and thoracic limbs		Girdle and pelvic limbs		Total	
	ni	%	ni	%	ni	%	ni	%
Berge allemand	0	0.0	2	2.6	5	6.6	7	9.2
Berger belge	0	0.0	0	0.0	0	0.0	0	0.0
Bichon	1	1.3	1	1.3	5	6.6	7	9.2
Boer Boël	0	0.0	3	4.0	9	11.8	12	15.7
Boston terrier	0	0.0	1	1.3	0	0.0	1	1.3
American Bully	0	0.0	0	0.0	0	0.0	0	0.0
Bull dog	0	0.0	0	0.0	0	0.0	0	0.0
Chihuahua	0	0.0	0	0.0	0	0.0	0	0.0
Cocker	0	0.0	0	0.0	0	0.0	0	0.0
Collie	0	0.0	1	1.3	0	0.0	1	1.3
Croisée	5	6.6	13	17.1	5	6.6	23	30.2
German Mastiff	0	0.0	0	0.0	4	5.3	4	5.3
Fox terrier	0	0.0	0	0.0	1	1.3	1	1.3
Jack Russel	0	0.0	1	1.3	65	6.6	6	7.9
Labrador	0	0.0	0	0.0	1	1.3	1	1.3
Mini loulou	0	0.0	1	1.3	0	0.0	1	1.3
Pit bull	0	0.0	0	0.0	1	1.3	1	1.3
Ridgeback	0	0.0	1	1.3	0	0.0	1	1.3
Rottweiler	0	0.0	2	2.6	1	1.3	3	3.9
Teckel	2	2.6	0	0.0	4	5.3	6	7.9
Yorkshire	0	0.0	0	0.0	1	1.3	1	1.3
Total	8	10.5	26	34.2	42	55.3	76	100

Legend: ni = absolute frequency, % = relative frequency.

Observations from this table reveals that dogs aged over 6 months belonging to the various crossbreeds (30.2%) followed by those

belonging to the Boer Boël breed (15.7%) were the most x-rayed.

Table 10: Distribution dog X-rays according to portions of the spinal column and according to gender (n= 8).

Portions	Males		Females		Total	
	ni	%	ni	%	ni	%
Cervical	1	12.5	1	12.5	2	25.0
Thoracic	0	0.0	0	0.0	0	0.0
Lumbar	1	12.5	2	25.0	3	37.5
Sacrum	1	12.5	2	25.0	3	37.5
Coccyx	0	0.0	0	0.0	0	0.0
Total	3	37.5	5	62.5	8	100

Legend: ni = absolute frequency, % = relative frequency.

From the table above, x-rays performed on different portions of the spine were more done on female individuals.

Table 11: Distribution of dog X-rays according to portions of the spinal column and according to age groups (n= 8).

Portions	From 0 to 6 months		From 7 to 24 months		Above 24 months		Total	
	n	%	ni	%	ni	%	n	%
Cervical	0	0.0	0	0.0	2	25.0	2	25.0
Thoracic	0	0.0	0	0.0	0	0.0	0	0.0
Lumbar	0	0.0	1	12.5	2	25.0	3	37.5
Sacrum	0	0.0	1	12.5	2	25.0	3	37.5
Coccyx	0	0.0	0	0.0	0	0.0	0	0.0
Total	0	0.0	2	25.0	6	75.0	8	100

Legend: ni = absolute frequency, % = relative frequency.

Data from table n^o10 indicate that the number of x-rays done according to age group, were done on dogs over 2 years of age.

Table 12: Distribution of dog X-rays according to spine portions and breed (n= 8).

Breeds	Cervical		Thoracic		Lumbar		Sacrum		Coccyx		Total	
	ni	%	ni	%	ni	%	ni	%	ni	%	ni	%
Germa Shepherd	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Belgium Shepherd	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Bichon	0	0.0	0	0.0	1	12.5	0	0.0	0	0.0	1	12.5
Boer Boël	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Boston terrier	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
American Bully	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Bull dog	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Chihuahua	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Cocker	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Collie	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Crossed breeds	0	0.0	0	0.0	2	25.0	3	37.5	0	0.0	5	62.5
German Mastiff	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Fox terrier	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Jack Russel	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Labrador	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Mini loulou	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Pet bull	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Ridgeback	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Rottweiler	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Teckel	2	25.0	0	0.0	0	0.0	0	0.0	0	0.0	2	25.0
Yorkshire	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	2	25.0	0	0.0	3	37.5	3	37.5	0	0.0	8	100

Legend: ni = absolute frequency, % = relative frequency.

From observations on table n^o12 more requests of radiography were made on crossbreeds.

Table 13: Distribution of dog X-rays done on the girdle and thoracic limbs according to limb region and gender (n=26)

Regions	Males		Females		Total	
	ni	%	ni	%	ni	%
Scapula	8	30.8	4	15.4	12	46.1
Forearm	1	3.8	1	3.8	2	7.7
Elbow	2	7.7	1	3.8	3	11.5
Forearm	3	11.5	4	15.4	7	26.9
Carpus	1	3.8	1	3.8	2	7.7
Cannon	0	0.0	0	0.0	0	0.0
Phalange	0	0.0	0	0.0	0	0.0
Total	15	57.7	11	42.3	26	100

Legend: ni = absolute frequency, % = relative frequency.

Table n°13 demonstrates that the number of x-rays taken according to gender, males were the most affected and much more for the scapular region.

Table 14: Distribution of dog X-rays on the girdle and thoracic limbs according to regions and according to age groups. (n=26).

Portions	From 0 to 6 moths		From 7 to 24 moths		Above 24 mois		Total	
	ni	%	ni	%	ni	%	ni	%
Scapula	0	0.0	3	11.5	9	34.6	12	46.1
Bras	0	0.0	1	3.8	1	3.8	2	7.7
Elbow	1	3.8	1	3.8	1	3.8	3	11.5
Forearm	1	3.8	2	7.7	4	15.4	7	26.9
Carpus	0	0.0	0	0.0	2	7.7	2	7.7
Canon	0	0.0	0	0.0	0	0.0	0	0.0
Phalange	0	0.0	0	0.0	0	0.0	0	0.0
Total	2	7.7	7	26.9	17	65.4	26	100

Legend: ni = absolute frequency, % = relative frequency.

Table n°14 reveals that the number of x-rays done on different age groups put individuals above 2 years old as the most affected especially on the shoulder.

Table 15: Distribution of dog X-rays on the girdle and thoracic limbs according to region and breed. (n=26)

Breeds	Scapula		Bras		Elbow		Forearm		Carpus		Cannon		Phalange		Total	
	ni	%	ni	%	ni	%	ni	%	ni	%	ni	%	ni	%		
German Shepherd	2	7.7	1	3.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	11.5
Blgium Shepherd	0	0.0	0	0.0	1	3.8	0	0.0	0	0.0	0	0.0	0	0.0	1	3.8
Bichon	0	0.0	0	0.0	0	0.0	1	3.8	0	0.0	0	0.0	0	0.0	1	3.8
Boer boel	1	3.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	3.8

Boston terrier	2 7.7	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	2 7.7
Bouly	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
Bull dog	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
Chihuahua	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
Cocker	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
Collie	0 0.0	0 0.0	0 0.0	1 3.8	0 0.0	0 0.0	0 0.0	1 3.8
Crossbreeds	5 19.2	1 3.8	2 7.7	4 15.4	1 3.8	0 0.0	0 0.0	13 50
German Mastiff	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
Fox terrier	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
Jack rusel	1 3.8	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 3.8
Labrador	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
Mini loulou	1 3.8	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 3.8
Pet bull	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
Ridgeback	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
Rott weiller	0 0.0	0 0.0	0 0.0	1 3.8	1 3.8	0 0.0	0 0.0	2 7.7
Teckel	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
York shire	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
Total	12 46.	2 7.7	3 11.5	7 26.9	2 7.7	0 0.0	0 0.0	26 100

Legend: ni = absolute frequency, % = relative frequency.

Data displayed on table n° 15 show that the forearm region was more involved in X-ray regardless of the race.

Table 16: Distribution of dog X-rays on the girdle and pelvic limbs according to regions and sexes. (n=42)

Regions	Males		Females		Total	
	ni	%	ni	%	ni	%
Pelvis	3	7.1	19	45.2	22	52.3
Thigh	4	9.5	5	11.9	9	21.4
Stifle	7	16.7	4	9.5	11	26.1
Hock	0	0.0	0	0.0	0	0.0
Cannon	0	0.0	0	0.0	0	0.0
Phalange	0	0.0	0	0.0	0	0.0
Total	14	33.3	28	66.7	42	100

Legend: ni = absolute frequency, % = relative frequency.

This table shows that the number of x-rays taken in relation to the sexes according to the regions of the pelvic girdle and the hind limbs, females were the most listed.

Table 17: Distribution of dog X-rays on the girdle and pelvic limbs according to regions and age groups. (n=42)

Regions	From 0 to 6 months		From 7 to 24 months		Above 24 months		Total	
	ni	%	ni	%	ni	%	ni	%
Pelvis	12	28.6	4	9.5	6	14.3	22	52.3
Thigh	3	7.1	5	11.9	1	2.4	9	21.4
Stifle	1	2.4	6	14.3	4	9.5	11	26.1
Hock	0	0.0	0	0.0	0	0.0	0	0.0
Canon	0	0.0	0	0.0	0	0.0	0	0.0
Phalange	0	0.0	0	0.0	0	0.0	0	0.0
Total	16	38.1	15	35.7	11	26.1	42	100

Legend: ni = absolute frequency, % = relative frequency.

According to the results in table n°17 dogs between 0 to 6 months followed by those between 7 to 2 years were the most X-rayed.

Table 18: Distribution of dog X-rays on the girdle and pelvic limbs according to region and breeds. (n=42)

Breeds	Pelvis		Thigh		stifle		Hock		Cannon		Phalange		Total	
	ni	%	ni	%	ni	%	ni	%	ni	%	ni	%	ni	%
German Shepherd	3	7.1	2	4.8	1	2.4	0	0.0	0	0.0	0	0.0	6	14.3
Belgium Shepgerd	1	2.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	2.4
Bichon	5	11.9	1	2.4	0	0.0	0	0.0	0	0.0	0	0.0	6	14.3
Boer Boël	2	4.8	1	2.4	5	11.9	0	0.0	0	0.0	0	0.0	8	19.0
Boston terrier	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
American Bully	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Bull dog	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Chihuahua	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Cocker	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Collie	0	0.0	1	2.4	0	0.0	0	0.0	0	0.0	0	0.0	1	2.4
Crossbeed	5	11.9	2	4.8	4	9.5	0	0.0	0	0.0	0	0.0	11	26.1
German Mastiff	2	4.8	0	0.0	1	2.4	0	0.0	0	0.0	0	0.0	3	7.1
Fox terrier	1	2.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	2.4
Jack Russel	1	2.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	2.4
Labrador	1	2.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	2.4
Mini loulou	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Pit bull	1	2.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	2.4
Ridgeback	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Rottweiler	0	0.0	2	4.8	0	0.0	0	0.0	0	0.0	0	0.0	2	4.8
Teckel	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Yorkshire	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	22	52.4	9	21.4	11	26.2	0	0.0	0	0.0	0	0.0	42	100

Legend: ni = absolute frequency, % = relative frequency.

Indications in table n°19 show that the pelvic region was the most x-rayed in all breeds.

Radio-diagnosed lesions of the musculoskeletal system: In addition, the

various lesions radio diagnosed on the different constituent parts of the musculoskeletal system in dogs are presented in tables 20, 21 and 22 below, supplemented by the corresponding radiographic images.

Table 19: Distribution of radio lesions on different spine portions.

Portions	Lesions	Number		Observations
		ni	%	
Cervical	Fracture of a cervical vertebra	2	25.0	Vertebral body fracture (C2 et C3)
Thoracic	None	0	0.0	
Lumbar	Fracture of a lumbar vertebra	3	37.5	Vertebral body fracture (L2 et L3)
Sacrum	Fractures	3	37.5	Anterior and posterior fractures et
Coccyx	None	0	0.0	
TOTAL		8	100	

Legend: ni= absolute frequency, %= relative frequency, C2= 2nd cervical vertebra, C3= 3rd cervical vertebra, L2= 2nd lumbar vertebra and L3= 3rd lumbar vertebra.

Observations from table n°19 show fractures to be located on lumbar and sacral portions of the spine

Table 20: Distribution of radio lesions localised on the girdle and thoracic limbs in dogs.

Regions	Lesions	Number		Observations
		ni	%	
Scapula		0	0.0	
Humerus	Ostéoporose de l'humérus	1	8.3	Dégénérative process of the proximal end of the bone
	Humeral Fracture	1	8.3	Diaphyseal fracture of the bone
Elbow	Olecranon fracture	2	16.7	Fracture of the proximal part of radius
Radius/Ulna	Fractures of radius and ulna	7	58.4	Most in the distal part of the two bones
	Osteosarcoma of radius	1	8.3	Proliferation of bone tissue around the distal part of the bone
Carpus	None	0	0.0	
Front pastern/carpals	None	0	0.0	
TOTAL		12	100	

Legend: ni=absolute frequency, %=relative frequency

The distribution of radio diagnosed lesions in dogs on the girdle and thoracic limbs described

in table n°20 shows the forearm region as the most affected area.

Table 21: Distribution of radio lesions diagnosed at the level of the girdle and pelvic limbs in dogs

Regions	Lesions	Number		Observations
		ni	%	
Pelvis	multiple pelvic fractures	7	25.0	Ilium and Ischium fracture associated with sacro-iliaques and Femur dislocations Ilium neck fracture Break in the ischial arch Flattening of acetabular cavities
	Ilium fracture	1	3.6	
	Ischium fracture	1	3.6	
	Hip dysplasia	1	3.6	
Thigh	Femur fracture	8	28.6	Femur break on different parts: neck, trochanter, diaphysis... Exit of the head of Femur from acetabular cavity
	Antero-superior dislocation of Femur	2	7.7	
Forelimb/leg	Fracture of tibia and fibula	8	28.6	Distal fractures of two bones
Foot	None	0	0,0	
TOTAL		28	100	

Legend: ni=absolute frequency, %=relative frequency

Results in table n°21 indicate the thigh region to be the most affected followed by that of the pelvis and stifle.

DISCUSSION

The discussion is based on the number of x-rays done in various animal species, and the distribution of x-rays showing lesions in the musculoskeletal system in canine species.

Number of x-rays taken on various animal species.: The results of our study demonstrated that the total number of X-rays taken on animals from various animal species is 202 images. Among them 103 (50.9%) relate to the canine species (Table 1). Indeed, the canine numerical importance noted during this investigation. This observation is due to the high number of dogs brought in for consultation. This observation corroborates the

investigations of Schwarz and Saunders (2023) and Piras and Cappai (2020) in Lubumbashi and of Holler (2024) in several other cities around the world. In addition, the table revealed that 71.8% against 28.2% of X-rays were respectively based on the request from the treating veterinarians and on the request of the owners. This distribution demonstrates that the veterinarian remains the only specialist in animal medicine as stated by Budsberg and Bergh (2020) and that any paraclinical examination, like radiography, must result from a judiciously conducted clinical examination as recommended by Cook and

Evans (2021); De Camp *et al.* (2021). Furthermore, it was observed that only 5.9% of the X-rays taken in the various animal species were non-compliant against 94.1%, or 197 compliant images (Table 2). From the compliant images, 137 images (i.e. 69.1 %) carried diagnostic information (Table 3). These results sufficiently demonstrate the merit of digital development against the manual development usually used in the hospital centre of the city of Lubumbashi. Dyce *et al.* (2022) and Griffon (2022) undeniably stipulate that digital development is a cutting-edge technique in imaging, a major asset that can guarantee quality additional examinations for a better care of animals. Development takes only 10 to 30 minutes. The sharpness of the images and the diagnosis are improved. According to these authors, the contribution of this X-ray film development system is a significant ecological effort because it spares the environment from the dissemination of toxic chemicals used during the development of silver X-rays.

Distribution of X-rays in Dogs: Observations from table 4 on the number and distribution of x-rays from canine species showed that males outnumbered females. The same observations were noted for results displayed in table 6 for breed and gender x-ray distribution. Indeed, several authors including Hansen (2023) and Lamb (2020) have mentioned the presence of various exotic, local breeds and their cross breed in the urban environment of Lubumbashi, while Mehl (2024) reports the high number of German Shepherd breed compared to other breeds and cross breeds. Moreover, during the last decades, many families in Lubumbashi have become interested in the production of purebred dogs. This would explain the large variation in the age of observed dogs. Results on musculoskeletal system data analysis revealed that the girdle and pelvic limbs and the girdle and thoracic limbs were more traumatised in male dogs than the spine. In females the latter

was much more involved (table 8). Corroborating Piermattei *et al.* (2022), the influence of the breed, age or gender of the animal cannot be demonstrated. On the other hand, proximity to a road and wandering and fighting behaviour would increase the risk of an accident as well as the probability of fracture and trauma. Besides, table 9 showed that the girdle and thoracic limbs were more radiographed on dogs older than 24 months; on the other hand, the girdle and pelvic limbs were more radiographed in animals aged between 7 and 24 months. These observations corroborate those made by Verhoeven and Saunders (2021) who states that when a dog ages, changes in the body's organs and systems first occur for maturation and then for aging. Furthermore, more x-rays were performed on the girdle and the thoracic limbs and on the spine for crossbreed dogs while the Boer Boël had more x-rays done on the girdle and the pelvic limbs (table 10). Unarguably some authors such as Griffon (2022) and Hansen (2023) consider that it is advantageous to have a crossbreed dog (mongrel or dog) due its genetic diversity and its low purchase cost compared to purebred dogs. The aforementioned authors add that for the Boer Boël breed qualities: large size, hunting qualities, its tendency to dominate same gender peers' space and territory demanding expression of its guardian qualities make this breed very expensive. Number and distribution of radiographs on various portions of the spine, revealed that the lumbar and sacral portions were the most x-rayed in females (Table 11), particularly on individuals above 24 months age (table 12) from Crossbreeds, Dachshund and Bichon breeds (table 13). Several authors such as Lamb (2020) and Montagne and Mehl (2024), interested in locating the sites of appearance of traumatic lesions in the spine, were able to establish the following decreasing order of frequencies: Lumbo- sacral, sacro caudal, thoracic and cervical. This observation confirms the results of the current study. The

results of our investigations also showed that in dogs, among the regions of the girdle and thoracic limbs, the scapula and forearm were more involved in the radiographic evaluation irrespective of the gender (Table 15), especially on dogs above 24 months (Table 15), and from essentially crossbreeds (Table 16). According to Smith (2015) traumatic injuries to the scapula are uncommon. They represent only 0.5 to 2.4% of all fractures in domestic carnivores. The same goes for those of the radius and ulna representing 17 to 18%. Holler (2024) indicates that males, more territorial than females, are often prone to fights. Regarding the girdle and pelvic limbs, it was observed that the pelvis and thigh, in females and the stifle in males were more subjected to x-ray (Table17). Investigations done by Kinns (2020) confirm that not all bones are subject to the same risks, and that in dogs involvement of the femur is most common (70% of cases). The results of this study have also demonstrated the same. In addition, these two regions were targeted by x-rays in dogs from different age groups; the stifle was more exposed to x-rays in individuals above 6 months (Table 18). Furthermore, the results from this study indicate that the thigh was more x-rayed in the following breeds: Bichon, German shepherd, Great Dane, Boer Boël, Rottweiler, and crossbreeds. It was also noted that crossbreed dog stifle was the most involved site of radiography (table19). These results are consistent with the findings of Griffon (2022) and Hansen (2023). These authors suspected that the above-mentioned regions could be much more exposed to trauma due to falls and traffic accidents, particularly among individuals from German shepherd breed. More studies on this topic are needed to confirm this hypothesis.

Radio-diagnosed lesions on the musculoskeletal system in dogs: The radiographic examination done on dog spine exposed the fracture of the cervical, lumbar

and sacrum vertebra (table19). In relation to this observation, Lamb (2020) points out that most investigations on spinal trauma exclude sacral pathologies from their research when they evaluate the regionalization of lesions occurring at the spine level. In terms of frequency, Alboury ranks fractures of the lumbosacral vertebra as dominant. The x-ray of the girdle and thoracic limbs uncovered cases of osteoporosis and fracture of the humerus, double proximal fracture of the radius and ulna and osteosarcoma of the radius (table 20). Study done by Griffon (2022) unveils that osteoporosis can develop quickly due to immobilization or poorly adapted osteosynthesis. Thus, a six weeks immobilization would lead to rapid bone loss. According to Hansen (2023), the distribution would be much longer, even random beyond 12 weeks. In addition, Dyce et al. (2022) demonstrates that most of humerus fractures involve the third middle and distal of this bone. De Camp et al. (2021). show that these fractures can sometimes be accompanied by paresis and paralysis of the thoracic limb caused by nerve damage. Besides they state that fractures of the distal end of the humerus would occur in most cases of minor trauma. As demonstrated by Holler (2024) forearm fractures represent 18.6% of fractures occurring on long bones including 5.1% on the radius, 3.1% on the ulna and 9, 8% on both. There is scarce information available for osteosarcoma. These tumors are common in dogs on front and hind limbs, but also on the head and on a cervical vertebra Hansen (2023). Data from table 21 indicate that the pelvic girdle and limbs, fractures of the ilium and ischium, poor pelvis development, fracture of the ilium, fracture of the ischium, fractures of the femur, femoral dislocation, tibial fractures, fracture of both the tibia and fibula were diagnosed. This observation corroborates with the results of De Camp et al. (2021). stating that dislocations of the femur, particularly in the cranio-dorsal direction, are very frequent

and that fractures of the pelvis, often open and multiple, correspond to 20-30% of fractures occurring in domestic carnivores. Kinns (2020) considers that the above-mentioned cases are due to the configuration which can be compared to a rigid frame composed of the hip bones and the sacrum. These structures being in relation to each other, a displaced fracture on one side will lead to another elsewhere in

the structure. It would therefore be necessary to take x-rays from at least two different angles. The author describes pelvic fractures distribution as follows:

- Iliac fractures: 18.2%
- Pubic rami (bills): 28.2%
- Acetabular fractures: 14.6%
- Ischium fractures: 23.1%
- Sacroiliac joint lesions: 15.9%

CONCLUSION AND APPLICATION OF RESULTS

Data from this study reveals that more than half of x-rays performed at the Lubumbashi Zoo Veterinary Centre from December 5, 2015, to November 19, 2018, are attributed to the canine species. Many of them were requested by the treating veterinarians. Their conformity (readability and interpretability) demonstrated the quality and merit of the digital development system for x-ray films. This study also showed that the x-rayed dogs belonged to various breeds and crossbreeds. Male dogs and those older than 24 months were the most x-rayed. In addition, it revealed that the girdle and the pelvic limbs, in particular the pelvis and the thigh, were the most stressed parts of the musculoskeletal system due the radiographic examination. The same noted from the shoulder and forearm to

the girdle and thoracic limbs. At the spine level, the lumbar region was the most exposed part to x-rays. Furthermore, the interpretation of different images from dogs allowed highlighting several lesions, often insidious on clinical examination, having affected the musculoskeletal system in dogs such as pelvic fractures, joint fractures and distal fractures. Therefore, it is suggested that the head of the veterinary centre mention on each photograph, beside the date, the names of the owners and of the animals, and the results of their respective reading (observed lesions). Veterinary practitioners, particularly those working in pet clinics, should include radiographic examinations in the treatment plan for musculoskeletal disorders.

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