Asian Journal of Medicine and Health

19(6): 1-8, 2021; Article no.AJMAH.69506
ISSN: 2456-8414

Radiographic Anatomy of the Abdomen of Local Breed Dogs

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Authors' contributions

This work was carried out in collaboration among all authors. Author KD conducted the study, wrote the protocol, took the radiographic images and wrote the first version of the manuscript under the direction of authors KM, GP, SL and AK who made their corrections for the validation of the final document submitted. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJMAH/2021/v19i630332
Editor(s):
(1) Dr. Janvier Gasana, Kuwait University, Kuwait.
Reviewers:
(1) Herinda Pertiwi, Airlangga University, Indonesia.
(2) Shehu Sidi, Usmanu Danfodiyo University, Nigeria.
Complete Peer review History: http://www.sdiarticle4.com/review-history/69506

Original Research Article

Received 05 April 2021
Accepted 11 June 2021
Published 19 June 2021

ABSTRACT

Objectives: The anatomical area that constitutes the abdomen is an area that is often subject to serious conditions. These diseases can affect the digestive and urogenital systems and radiography is a complementary examination of choice to refine the diagnosis. This study had for objective, to realize a radio anatomical atlas of the Abdomen in order to facilitate the comprehension and the interpretation of the radiographic pictures of the dog.
Methodology: To do this, radiographs were performed on the Abdomen of 30 healthy dogs including 15 females and 15 males, (all of local breed) received at the radiology room.
Results: At the end of the study, the best normal pictures by anatomical region and by incidence of the normal pictures of the Abdomen, were selected constituting a reference database in radiographic anatomy of this animal. Each radiograph is commented and annotated, facilitating the understanding of the images. These radiographic images will serve as a basis for the interpretation of radiographic images of the abdomen in the dog.
Conclusion: These radiographs will serve as a basis for the interpretation of radiographic images of the abdomen of the dog.

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Keywords: Anatomy; abdomen; dog; radiography.

1. INTRODUCTION

Veterinary medicine is a multidisciplinary field. Medical imaging, in particular, is a transversal specialty, at the junction of internal medicine, surgery, intensive care, and many others. It is therefore an essential diagnostic tool for the clinician on a daily basis. As part of Medical Imaging, radiography is the fixation on a plane support of three-dimensional structures projected by a beam of incident X-rays. These X-rays interact with a photosensitive emulsion deposited on the radiographic film and this interaction will be made visible by the development of the film. Thus, any non-ideal projection will give a distorted image of the real object [1].

This type of medical application is mainly indicated for obtaining images of the skeleton, the lungs, the abdominal cavity or the udder. For example, when a tumor process is suspected, the diagnostic approach consists of locating the primary tumor and then performing a local-regional and general extension assessment.

Thus, in current practice, some tumors are easier to diagnose, such as skin tumors. On the other hand, the diagnosis of deep tumors is more difficult, on the one hand because the suspicion of a deep tumor is generally later and based on clinical signs that are not very specific, and on the other hand because the confirmation of this suspicion requires the use of medical imaging techniques (radiography...). Imaging techniques are therefore very important for the localization of a primary tumor, but also for the realization of an extension of a tumor at the abdominal level.

Although radiography is a very accessible examination in practice, the interpretation of the images obtained requires a good knowledge of the anatomy, as well as of the normal radiographic aspect, for a given species. Radiography is a discipline which, in addition to the indispensable theoretical knowledge, requires visual training. It is for this reason that this study aimed to describe the radiographic anatomy of the dog's abdomen in order to facilitate the understanding and interpretation of radiographic images of the dog and to constitute a significant aid to the interpretation of our patients' images.

2. MATERIALS AND METHODS

2.1 Area, Period of the Study

The veterinary clinic of the EISMV of Dakar is located within the establishment at the University Cheikh Anta Diop (U.C.A.D) of Dakar in the Fann district. It is a referral clinic that is currently one of the most frequented veterinary clinics in the city of Dakar due to the quality of the services offered to patients. This study took place from June 2018 to August 2019.

2.2 Materials

2.2.1 Animal material

To conduct this study, we used unanesthetized dogs, regardless of weight, age, and size. These were dogs presented in the radiology room for routine radiography, and whose owners had agreed to their participation in the study. Dogs were recruited as they arrived in the radiology room. We thus recruited a total of 30 patients including 15 females and 15 males, between 6 months and 4 years old (all of local breed). The animals were healthy animals, referred by clinicians at the EISMV University Hospital and also by clinical veterinarians in private practice for routine examinations, and brought by the animal owners.

2.2.2 X-ray equipment

The Inter-State School of Veterinary Science and Medicine in Dakar has a radiology room in the clinic where this study was conducted.

The radiographic apparatus used is of the brand CAWOWAT and is a silver radiographic equipment. This device has maximum voltage (kV), 150 kV, and maximum second milliamperage, 300 mas. In our study, KV ranged from 52 to 120 for the thorax and 41 to 91 and mas ranged from 4-5 for the thorax and 10 for the abdomen.

The adjustment of these parameters was done thanks to the control panel of the radiographic apparatus by the operator.

2.3 Methods

2.3.1 Restraint of the animals

No physical or chemical restraint was required. Our animals were brought by their owners; this allowed us to perform the manipulations in complete tranquility. The presence of the owners was a reassuring factor, avoiding the need for physical and medicinal restraint.

2.3.2 Technique of realization of the radiography of the abdomen

In order to improve the quality of the radiographic examination of the abdomen, it was preferable that the stomachs are empty of food. An overfilled bladder could also interfere with the examination of other abdominal organs due to the mass effect. It was therefore advisable to have the animal urinate or to empty the bladder by external cabs before taking abdominal pictures. The coat should be cleaned of debris that may cause suspicious images on the radiograph. All Standard abdominal examination should include at least two orthogonal projections: one ventro-dorsal and one lateral (Figs. 1 & 2). The images were taken at the end of expiration. The technical quality of the radiograph was evaluated according to the positioning of the animal, the exposure, the sharpness and the contrast of the image. The entire abdomen should be seen and the center of the abdominal cavity should be superimposed on the center of the radiographic film. The lumbar vertebrae should be moderately exposed and the abdominal viscera should be seen. The outline of the organs and abdominal wall should be clear. The range of gray should be sufficient [2-4].

Fig. 1. Lateral view of the dog's abdomen (Photo KABKIA)

Fig. 2. Dorso-ventral view of the dog's abdomen (Photo KABKIA)

2.3.2.1 Position of the animal

In ventro-dorsal incidence, the dog is in ventral decubitus. The pelvic limbs are in extension. The x-ray beam is centered in front of the umbilicus and the field is open from the xyphoid appendage to the hips. In lateral incidence, the dog is in left lateral decubitus. The pelvic limbs are in extension, pulled caudally. The X-ray beam is centered on the flank recess and the field is open from the xyphoid appendage cranially to the greater trochanters caudally [2-4].

2.3.2.2 Quality criteria

At ventro-dorsal incidence, the quality of the abdominal image was good if the whole abdomen was contained on the image and there was symmetry of the right and left parts of the abdomen. In lateral incidence, an abdominal radiograph was of good quality if the entire abdomen was contained on the film, from the diaphragm to the entrance of the pelvis, and if there was no superimposition of the ribs at their base and the pelvic limbs are clear of the caudal part of the abdomen so as not to obliterate the observation of the organs on the film [2-4].

2.3.3 Selection and obtaining of the images included in the thesis

The best images were chosen by assessing the incidence, position and quality criteria stated in our methodology for taking radiological images [2-4].

The different images were placed on the view box and pictures were taken with the digital camera. In addition, for each image, arrows were used to annotate the characteristic anatomical elements in order to facilitate the understanding of the images. Finally, with the Windows Screen Capture and Sketch Tool software, the arrowed and numbered images were captured in order to avoid moving the arrows.

3. RESULTS

3.1 Left Lateral Incidence (Fig. 3)

The abdominal cavity is bounded cranially by the diaphragm, dorsally by the sublumbar muscles and diaphragm, and laterally and ventrally by the abdominal wall muscles and diaphragm. The abdominal wall consists of skin, subcutaneous tissue, fat and muscle layers and the parietal peritoneum. The lateral projection shows the ventral abdominal wall. It is formed from the inside to the outside: the parietal peritoneum, the rectus abdominis muscle, the transverse abdominis muscle, the internal and external oblique muscles. It gradually thins from the pelvic region to the hepatic region and is often no longer visible ventrally at the liver. The sublumbar muscles mark the most dorsal limit of the abdominal cavity, originating ventrally from the last thoracic vertebrae and the first lumbar vertebrae, and inserting onto the pelvis and femur. They form a fluid opacity with a ventral border that progressively thins in the caudal region. The sublumbar region also contains other structures (ureters, aorta, caudal vena cava, lymph nodes, etc.) that are not visible on a normal film because their size is small and their opacity is identical to that of the sublumbar muscles.

The liver is a large organ occupying the cranial part of the abdomen and located against the diaphragmatic dome. Its parenchymatous nature gives it a homogeneous liquid opacity. On this projection, the caudo-ventral end of the liver protrudes moderately from the hypochondrium.

As a parenchymal organ, the spleen appears with a homogeneous fluid opacity on radiography. Its position is variable depending on the degree of blood engorgement and the volume of the stomach. On a lateral projection, we usually distinguish the most ventral part of the spleen.

On a left lateral projection, the silhouette of the stomach, the circumvolutions of the jejuno-ileum and the colon were visible. The stomach is located in the cranial part of the abdomen. The radiographic opacity of the stomach as well as its visibility depends on its contents and its degree of distension. When it is completely empty or when it contains only liquid, its silhouette is superimposed on the hepatic shadow and its contours are difficult to delineate except for its caudal side. When it contains food, it is more visible and takes on a rather heterogeneous granular appearance. The most important factor in the variation of the radiographic appearance of the stomach is the radiographic projection, which influences the distribution of gas and liquid in the stomach lumen. The jejuno-ileum convolutions are visible throughout the ventral abdominal quadrant. Radiographically, only a few intestinal coves can be distinguished. Their tissue opacity can be appreciated, heterogeneous or aerial depending on their liquid, food or gas content. In the caudal abdominal part, in the sub-lumbar region, the descending colon is generally visible because it contains stool and gas. The stool gives it a rather opaque, more or less granular and heterogeneous appearance.

On a left lateral projection of the abdomen, the kidneys and bladder can be distinguished. The kidneys are located in the retroperitoneal region. They are generally bean-shaped with the long axis approximately parallel to the spine. On a left lateral projection, the two kidneys of the dog appear superimposed on each other, under the lumbar vertebrae. The right kidney being in a more cranial position than the left kidney, it is possible to distinguish the cranial pole of the right kidney and the caudal pole of the left kidney.

The bladder is located in the caudo-ventral part of the abdomen. It appears radiographically as an oval image which appears white. The size of the bladder obviously depends on the amount of urine it contains.

3.2 Ventro-Dorsal Projection (Fig. 4)

The ventro-dorsal projection allows visualization of the lateral walls of the abdomen. It is composed of the external oblique, internal oblique, and transverse abdominal muscles from the outside to the inside. The liver presents a homogeneous fluid opacity with a convex diaphragmatic side and a concave visceral side. On a ventro-dorsal projection, it is located against the diaphragm and the cranial abdominal walls, below the last ribs. The craniodorsal end of the spleen is visible in the left cranial abdominal quadrant, caudal and lateral to the gastric fundus. It forms a fairly characteristic triangular image of fluid opacity. On a dorsoventral projection of the abdomen, the stomach and the jejunoileal convolutions are visible. The organ then projects caudally to the last left rib and the corresponding part of the epigastric region. This projection may extend far posteriorly in extreme repletion, as far as the fifth or sixth lumbar vertebra. The small bowel convolutions are visible throughout the right side of the abdomen. Located on either side of the median plane, the kidneys appear radiographically as organs of homogeneous fluid opacity. The hilum, marked by a concave depression, appears medially. The right kidney is located more cranially than the left kidney.

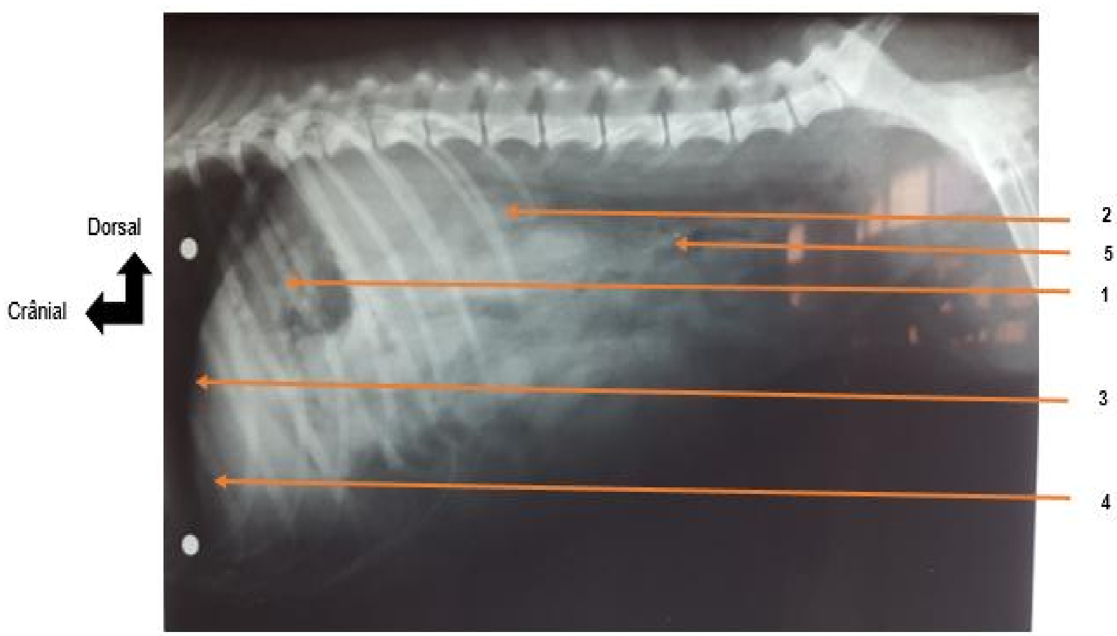

Fig. 3. X-ray of the abdomen in left lateral incidence (Photo KABKIA)
1= Stomach; 2= Right kidney; 3 = Diaphragm; 4 = Liver; 5 = Small intestine

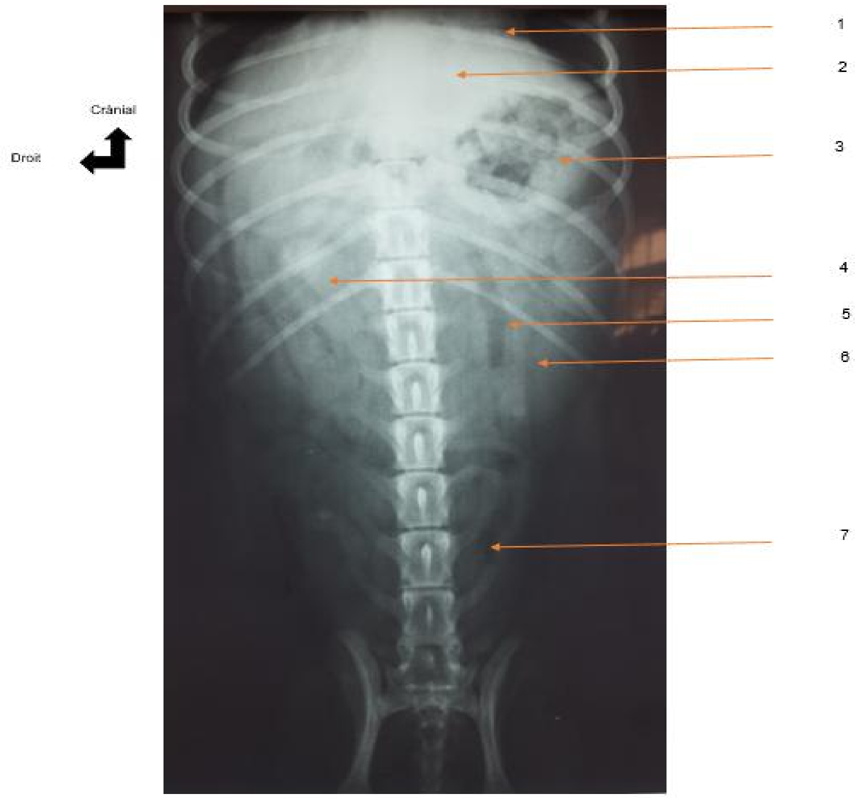

Fig. 4. X-ray of the abdomen in ventro-dorsal view

1= Diaphragm; 2= Liver; 3 = Stomach; 4 = Right kidney; 5 = Small intestine; 6 = Left kidney; 7 = Colon

4. DISCUSSION

The anatomical area, especially the abdomen, was chosen taking into account the frequency of diseases in animals received at the EISMV clinic in Dakar in general and in domestic carnivores in particular. Indeed, according to some authors [5,6,7,8], the diseases of the following systems are numerous and varied. These diseases can affect the digestive system. We can mention as examples of pathologies, foreign bodies, dilatation/torsion syndromes and intestinal tumors. They can also affect the urogenital system. Examples of pathologies include hydronephrosis, pyelonephritis, polycystic nephritis, urolithiasis, ureteral ectopia, congenital malformation, cystitis, ureteral calculi, prostatitis.

The veterinary clinician must therefore be familiar with radiographic anatomy in order to interpret the various images.

We used a silver radiographic apparatus for our study, being the apparatus available in the radiology room of the EISMV. In silver radiography, the development of radiographic images requires the use of fixing and developing solutions, products which for the most part are not without danger, because they are carcinogenic. Apart from this major disadvantage, digital radiography offers the possibility of printing the radiographic images on paper or storing them in the computer. These images stored in the computer can be used if necessary. On the other hand, in silver radiography, the X-rays impress the photographic emulsions present on the radiographic film. This film is then made visible by processing. This is a chemical reaction. The X-ray films obtained are thus put on a negatoscope and photographs are carried out via a digital camera of the cliché obtained for its exploitation. Another disadvantage of taking photographs is that the image is modified and the quality of the images is altered. In spite of all these disadvantages, the silver X-ray camera has the advantage of having a higher spatial resolution than the digital X-ray camera [9,10].

The method of interpretation of the radiographic images was the same as that used by GASSE in 2008, LEBAS in 2008, SCHEVENEMENT in 2010, CHATOR, 2010, FANG et al, 2021 and LI and al, 2021 who had to work respectively on chinchilla, ferret, dog and red fox. This interpretation method is based on the appreciation of density, contrast, sharpness, position and centering and framing. However, a different method of interpretation of radiological images was used by GATTI in 2006 in horses [3,4,11,12,13,14]. Indeed, for each horse and each radiographic workup, any original, suspicious or abnormal image is noted on a summary sheet detailing all potential osteoarticular lesion sites. Each image is characterized and graded and these grades correspond to a number of points, directly dependent on their severity. The sum of all the points of each horse allows to establish its osteoarticular status. It should be noted that, in general, the interpretation of radiographic images is much easier with digital radiography and the images obtained with digital radiography are of as good, if not better, quality than with silver radiography. In fact, with film radiography, the operator must sometimes choose between the quality of the contrast and the detail of the spatial resolution. Digital radiography offers a much larger scale of gray levels for each pixel of the sensor. This makes it possible to detect minimal differences between the X-rays arriving on the sensor, the contrast is increased and a slight under or overexposure may not hinder the interpretation of the image which can be reworked by the software. This feature has two advantages. It is much rarer than in conventional radiography to have to repeat the image. Moreover, on the same image, it becomes possible to study very different tissues (such as soft tissue and bone for example). Associated with this gain in contrast, the number of pixels theoretically limits the spatial resolution, which becomes less good than on high quality films. However, this resolution remains higher than what the human eye is capable of detecting. Digital technology also offers the advantage of being able to annotate images and make measurements while keeping a copy of the original image.

5. CONCLUSION

The aim of this study was to produce a radio-anatomical atlas to facilitate the understanding and interpretation of radiographic images of the dog's abdomen. At the end of our study, we obtained radiographic images that were annotated and that will serve as a basis for the interpretation of radiographic images of this important anatomical region.

CONSENT

It is not applicable.

ETHICAL APPROVAL

Animal Ethic committee approval has been taken to carry out this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/69506