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Radiographic Anatomy of the Canine Thorax

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1. Abstract

The dog is one of the most common pets in Africa in general and in Senegal in particular. The thorax is an anatomical region that is often the site of several pathologies such as chronic bronchitis, cardiogenic pulmonary edema, false swallowing, diffuse bronchial carcinoma, metastases, pneumonia and granulomatous diseases. Having the radiographic anatomy is essential for the interpretation of the thorax. The aim of this study was to produce a radiographic anatomical atlas of the thorax in order to facilitate the understanding and interpretation of radiographic images of the dog. For this purpose, radiographs were performed on the thorax of healthy dogs received at the radiology room. At the end of the study, the best normal radiographs were selected constituting a reference database of radiographic anatomy of this animal. Each radiograph is commented and annotated, facilitating the understanding of the pictures. These radiographs will serve as a basis for the interpretation of radiographic images of the thorax in the dog.

2. Introduction

The thoracic cavity of domestic carnivores consists of four compartments: the extrapleural space, the pleural space, the pulmonary compartment and the mediastinum. The mediastinum is central, confined between the two hemithoraxes along the longitudinal axis of the thoracic cavity. This location is, on the one hand, thoracic and, therefore, an integral part of a functional cavity structure with protective walls within which a play of pressures essential to cardiorespiratory physiology takes place.

The mediastinum, for example, houses the "noble" structures of three of the body's major anatomical systems (circulatory, respiratory and digestive systems), due to its central and cranial position. Thus, the diseases that affect it quickly have systemic repercussions and can lead to medical and/or surgical emergencies.

Radiology is a medical science specialty that uses either ionizing radiation or X-rays to obtain images of various anatomical structures. This type of medical application is mainly indicated for obtaining images of the thoracic cavity [16].

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 appearance, for a given species. Furthermore, teaching the interpretation of a dog radiograph is currently underdeveloped in the veterinary curriculum. Radiography is a discipline which, in addition to the necessary theoretical knowledge, requires visual training. It is for this reason that this study aims to describe the radiographic anatomy of the axial skeleton of the dog 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.

3. Materials and Methods

3.1 Area, Period of 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.

3.2 Materials

3.2.1. 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. 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.

3.2.2. X-ray Equipment

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

The radiographic apparatus used is of the brand

CAWOWAT. This device has the following characteristics:

- Maximum voltage (kV): 150 kV
- Maximum second milliamperage: 300 mAs

The adjustment of these parameters is done thanks to the control panel of the radiographic apparatus.

3.3 Method

3.3.1. Restraint of the Animals

We did not need any physical or medicinal restraint. 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.

3.3.2. Technique for Performing the Thorax Radiography

As for all regions, at least two orthogonal incidences (Figures 1 and 2) are necessary: a frontal projection (dorso-ventral or ventro-dorsal) and a lateral projection (right or left lateral decubitus). The choice of the lateral projection is of little importance; the main thing is to always use the same position in order to compare the images. When the animal is lying on its side, the lung farthest from the table is ventilated the most, whereas the lung in the down position is ventilated much less. The choice of the front projection is decided according to the type of suspected disease. The dorso-ventral projection is indicated for the examination of the heart. The ventro-dorsal projection is indicated for the study of the deep respiratory system because it allows a better visualization of the pulmonary field.

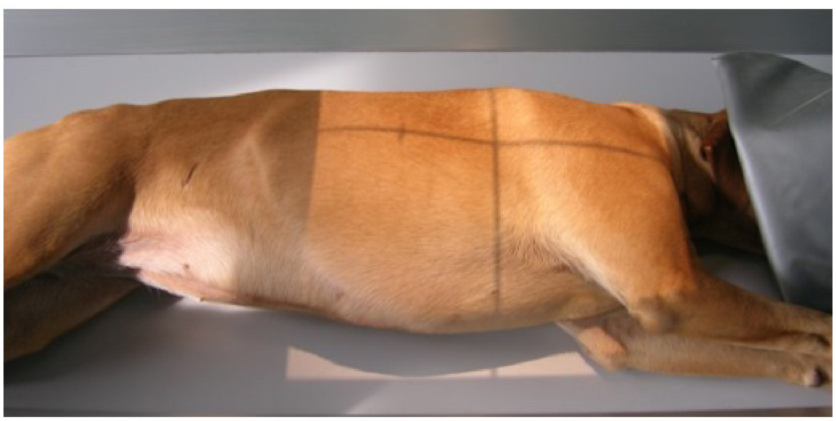

Figure 1: Lateral incidence of the thorax (Photo KABKIA)

Figure 2: Ventro-dorsal incidence of the thorax (Photo KABKIA)

3.3.2.1. Position of the Animal

In lateral incidence, the dog is in left lateral decubitus. The neck is in extension. The thoracic limbs are brought forward. The X-ray beam is centered at the caudal border of the scapula, in the ventral third of the thorax. The field is open to the cranial part of the shoulder and includes the sternum. In ventro-dorsal incidence, the dog is in dorsal decubitus. The neck is in extension. The X-ray beam is centered caudal to the scapulae on the midline. The field is open to the cranial part of the shoulder [2, 3, 13].

3.3.2.2. Quality Criteria

In lateral incidence, the thorax is contained in the image and the radiograph is centered at the tracheobronchial bifurcation. In addition, the ribs are superimposed at their base. Finally, the thoracic limbs are clear of the cranial part of the thorax. A chest X-ray with ventro-dorsal incidence is of good quality and successful if the whole chest is contained on the film and there is symmetry of the two hemithoraxes, superimposition of the spine and sternum and the diaphragm [2, 3, 13].

3.3.4. Selection and Obtaining of the Images Included in the Article

The best images were chosen by assessing the incidence, position and quality criteria stated in our methodology for taking radiological images [2, 3, 13].

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.

4. Results

4.1 Lateral Incidence (Figure 3)

The thoracic cavity consists of the thoracic spine, sternum, ribs, and parietal soft tissue (skin, subcutaneous tissue, musculature). The thoracic vertebral bodies form the dorsal limit of the thoracic cavity. The caudal lobes of the lungs project partially onto the thoracic vertebrae, which then appear more transparent. The ventral limit of the thoracic cavity is formed by the seven sternae and the xiphoid process. The chondro-costal junctions are visible at mid-thorax. With age, these junctions may become mineralized and, projecting onto the lung area, may be confused with tumor nodules.

The diaphragm is a musculotendinous structure that caudally limits the thoracic cavity, separating it from the abdominal cavity. It is radiologically visible because it separates the thoracic cavity with aerial content from the abdominal cavity with fluid content. However, it is not individually visible because of the close contact with the liver. It has a convex shape in the cranial direction. The appearance of the diaphragm is variable depending on the radiographic projection used (right or left). Dorsally, the hemi-cupolas form two slightly offset lines. The hemi-cupola that projects most cranially is the one on the side of the table; it is displaced cranially under the pressure exerted by the abdominal mass.

The mediastinum is the medial space of the thoracic cavity between the two lungs. It can be divided into three distinct regions. Dorsally, the cranial mediastinum contains the trachea in contact with the esophagus, which is not visible on a normal x-ray. On a lateral projection, the craniodorsal mediastinum forms a relatively opaque area, within which the tubular transparency of the trachea is visible. The ventral border of this craniodorsal mediastinum is formed by the ventral border of the caudal vena cava. The middle mediastinum contains the heart. Dorsally, the tracheobronchial bifurcation can be distinguished. The caudal mediastinum contains the aorta dorsally. The caudal vena cava can be seen medially.

The trachea appears as a tube of regular diameter and aerial opacity. The thoracic portion of the trachea is relatively straight and forms an acute angle of approximately 30° with the spine. At the terminal region of the trachea, the tracheobronchial bifurcation can be seen, in the middle of the base of the heart.

The thoracic cavity contains two lungs that are not exactly symmetrical in size, shape and lobation. The lobes of the lungs are indistinguishable from each other. The bronchial tubes, which normally contain air, are difficult to distinguish of the alveolar tissue, which is also aerated and therefore radiolucent. The pulmonary arteries and veins are normally closely adherent to the bronchial walls. The bronchial wall is normally too thin to be visible. On the X-ray, we can still see the start of the large bronchi at the tracheobronchial bifurcation.

The X-ray only shows the cardiac silhouette. Indeed, the blood and the cardiac muscle have the same liquid and homogeneous radiographic opacity. This cardiac silhouette is formed by all the structures in contact with the heart, namely the pericardium, the pulmonary hiliary structures, the tracheobronchial lymph nodes and the large vessels at the base of the heart. It forms a homogeneous ovoid image of fluid opacity with a relatively smooth and regular contour. On a lateral projection, the apex is directed ventro-caudally. The cardiac cavities cannot be differentiated radiographically from the cardiac walls. Overall on a left lateral projection, the dorsal part of the heart corresponds to the atria and the large vessels, the ventral part to the ventricles. The long axis of the heart separates the projection area of the right ventricle (cranio-ventral) from that of the left ventricle (caudo-dorsal). The head is composed of two parts: the face in rostral region and the skull in caudal region. On this projection, we note that the face is relatively short and constitutes about one third of the length of the head. At the level of the facial region, the nasal cavity is included between the nasal bone dorsally and the incisal bone ventrally. Caudal to the nasal cavity and dorsal to the palatine bone, are located the nasal turbinates at the level of the volutes of the ethmoid and the sieve blade of the ethmoid bone. In the oral cavity, the teeth: incisors, canines, premolars and molars are visible. Ventrally, we distinguish the body, the angle and the ascending branch of the mandible. The articular process of the mandible which articulates with the temporal bone is also visible. The frontal bone is in continuity with the nasal bone and it is noticeable that the skull of the dog has an overall flattened shape. In the center of the skull region, we can distinguish the parietal bone. Ventrally and caudal to the parietal bone, the petrous portion of the temporal bone appears with a more pronounced radiodensity. The caudal end of the skull is formed by the occipital bone emitting dorsally the occipital protuberance that clearly forms an angle and ventrally the prominent occipital condyle that articulates with the first cervical vertebra. In the ventral region of the skull, we distinguish the tympanic bullae and the hyoid apparatus.

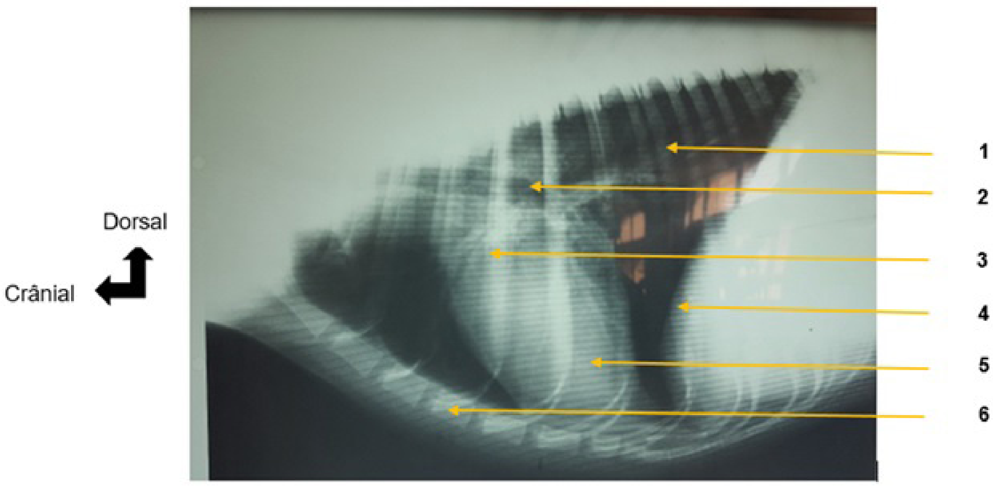

Figure 3: Radiograph of the thorax in left lateral incidence (Photo KABKIA)
1= Lung; 2= Trachea; 3= Pulmonary arteries; 4= Diaphragm; 5= Heart; 6= Sternum

4.2 Ventro-Dorsal View (Figure 4)

The diaphragm is curved dorsoventrally and laterolaterally and it provides costo-diaphragmatic recesses. The cranial border of the diaphragmatic dome is more cranial on the right than on the left.

On a frontal projection, the cranial mediastinum forms a band of fluid opacity superimposed on the spine and protruding moderately on either side of it. The trachea is not visible on a frontal projection because it is superimposed on the cervical spine and the sternum.

The cardiac silhouette appears obliquely placed in the thoracic cavity with respect to the median plane. The apex protrudes to the left of the median plane and the cardiac silhouette is more prominent on the left than on the right. On a frontal projection, the atria project cranially and the ventricles caudally.

5. Discussion

The anatomical area radiographed in our study, the thorax, was chosen taking into account the frequency of ailments in animals received at the EISMV clinic in Dakar in general and in domestic carnivores in particular. Indeed, according to some authors [3, 6, 10, 15, 17], there are many and varied diseases of the respiratory system (chronic bronchitis, cardiogenic pulmonary edema, false swallowing, diffuse bronchial carcinoma, metastases, pneumonia and granulomatous diseases).

Radiography is therefore an ideal means to explore the different structures, hence the need to master the normal radiographic anatomy of this anatomical region.

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 are not without danger, as they are carcinogenic.

Digital radiography allows the radiographic image to be printed on paper, or stored in the computer. These images stored in the computer can be used as needed. 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. Despite all these disadvantages, the silver X-ray camera has the advantage of having a higher spatial resolution than the digital X-ray camera [4, 7]. The spatial resolution corresponds to the number of pixels (elementary points) on the image. The higher the resolution, the finer the image. Conventional imaging has a spatial resolution of 10 line pairs/millimeter, up to 20 in mammography. It also has a better spatial resolution than digital radiology (3 to 10 pairs of lines / millimeters (pl/mm) for radioluminescent memory screens (ERLM), 8 to 13 in DR digital mammography (Direct Radiology) and 2.5 to 3.5 pl/mm for DR digital radiology). Thus, silver radiography provides a finer radiographic image than digital radiography [4, 7]. Then, even if the use of image processing allows to improve the quality of digital images, some manipulators can also see their judgment distorted by too many manipulations of the image with the software. The image manipulations generate the appearance of new artifacts, sometimes unknown, which can be misinterpreted. In spite of a considerable comfort of use, the manipulator must remain vigilant and avoid certain traps during the interpretation of the images. Finally, CCD sensors are less efficient than X-ray films in terms of signal/noise ratio. The "noise" is a parasitic signal. It is represented, on the image, in the form of fine and sharp spots, masking the finest details of the radiographic image. There is a proportional relationship between noise and X-ray exposure: when the exposure decreases, there is an increase in noise on the image. The Signal-to-Noise Ratio (SNR) designates the quality of information transmission (diagnostic information) in relation to interference (noise). The higher the SNR, the better the information in the image, and the less noise in the system. The SNR of radiographic films, according to the data provided by the manufacturers, is about 40 dB. In the study conducted by PELLERIN et al. in 1997 [12], the SNR values of CCD sensors range from 30.5 to 20 dB.

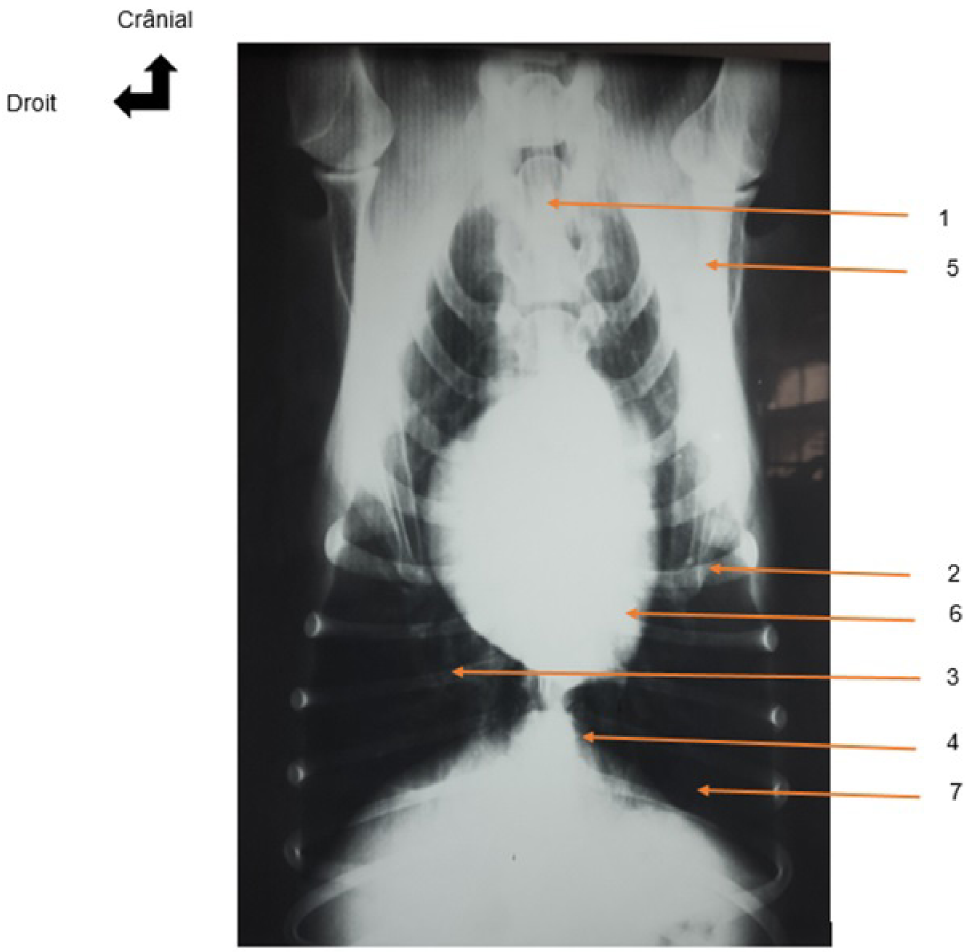

Figure 4: X-ray of the thorax in ventro-dorsal incidence (Photo KABKIA)
1= Trachea; 2= Rib; 3= Right lung; 4= Diaphragm; 5= Scapula; 6= Heart; 7= Left lung

The method of interpretation of the X-ray images was the same as that used by GASSE in 2008, LEBAS in 2008, SCHEVENEMENT in 2010, and CHATOR, 2010, who had to work respectively on chinchilla, ferret, dog and red fox [3, 5, 9, 13]. This method of interpretation is based on the assessment 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 [6]. 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, the spatial resolution is still better than what the human eye is able to detect. Digital technology also offers the advantage of being able to annotate images and make measurements while keeping a copy of the original image.

6. Conclusion

The aim of this study was to produce a radio-anatomical atlas of the abdomen in order to facilitate the understanding and interpretation of radiographic images of the axial skeleton of the dog. 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.

References

1. Bacher K, Smeets P, Bonnarens K, De Hauwere A, Verstraete K, Thierens H. Dose reduction in patients undergoing chest imaging: digital amorphous silicon flat-panel detector radiography versus conventional film-screen radiography and phospor-based computed radiography. AJR. 2003;181: 923-9.
2. Barthez, P. Technique en radiologie des petits animaux. Paris :CN-VSPA-PMCAC. 1997; 180p, 1997
3. Chator O. 2010. Atlas radiographique du renard roux (Vulpes vulpes), Thèse: Med. Vet : Toulouse; 10.
4. Farman A., Farman T, 2004. A status report on digital imaging for dentistry, Oral Radiol 2004; 20: 9-14.
5. Fossog Tine FX., 2008. Evaluation de la demande et du cout des analyses complémentaires dans les cliniques vétérinaires privées de la région de Dakar, Thèse : Med. Vet : Dakar. 2008; 08.
6. Gasse S. Contribution radiologique et ostéologique à la connaissance du Chinchilla (Chinchilla lanigera), Thèse: Med.Vet : Toulouse. 2008; 08.
7. Gatti J. Evolution radiographique des membres (pieds exceptés) de soixante deux chevaux entre trois et seize ans. Thèse : Med. Vet: Alfort. 2006; 06.
8. Hudda W, Rill L, Benn DK, Pettigrew JC. Comparison of a photostimulable phosphor system with film for dental radiology. Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 1997; 83: 725-31.
9. Humbert G, 2000. Comparaison de différents systèmes radiographiques dentaires appliqués à la pratique quotidienne (argentique-numérique). Thèse : Chir. Dent., Nancy. 2000; 123.
10. Kouakou Deassath HB. Etude rétrospective des cas cliniques de carnivores domestiques vus en consultation médicale a l'EISMV de Dakar de 2005 à 2010, Thèse: Med. Vet: Dakar. 2010; 10.
11. Lebas S. Atlas radiographique du furet (Mustela putorius furo), Thèse : Med. Vet : Toulouse. 2008; 08.
12. Lee W, Choi B. Reliability and validity of soft copy images based on flat-panel detector in pneumoconiosis classification : comparison with the analog radiographs. Acad Radiol. 2013; 20: 746-51.
13. Mai W. Guide Pratique de Radiographie canine et féline. Paris : Editions MED'COM. 2003; 350p.
14. Pellerin Y, Le Denmat D, Legras A. Qualité physique des imageurs dentaires numériques. Inf Dent. 1997; 40: 3025-8.
15. Schevenement A. Choix comparatif d'une technique d'investigation par imagerie médicale des tumeurs intra-thoraciques chez le chien. Thèse : Med. Vet : Lyon. 2010; 10.
16. Solacroup B, et Le Marec SC. Bases physiques des rayons X. 2001. 21 p.
17. Van Heesewijk HP, Van Der Graaf Y, De Valois JC, Vos JA, Feldberg Mam. Chest imaging with a selenium detector versus conventional film radiography: a CT-controlled study. Radiology. 1996; 200: 687-90.