

EVALUATION OF ENTRANCE SURFACE-SKIN DOSES IN ANIMALS SUBMITTED ON EXAMS OF ABDOMEN IN VETERINARY RADIOLOGY USING TL DOSIMETRY

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Abstract

The radiation protection has recently gained considerable attention in human medicine. In veterinary medicine has been some advances in radiodiagnostic and therapy for domestic animal like dogs and cats. It is notable the increase of the costs with domestic animals that are considered, by many people in the whole world, like members of family. However, an important parameter that must be taken into account is the increasing use of computed tomography and other equipments that uses ionizing radiation, which may lead to comparatively high exposure of critical organs. The radiation dose is determined by the balance between therapeutic benefit and possible damage to surrounding normal tissues. This study aimed the evaluation of entrance surface-skin doses in dogs submitted to radiodiagnostic procedures of abdomen using the technique of thermoluminescent dosimetry (TLD). The radiation doses were measured using thermoluminescent dosimeters of LiF:Mg,Ti (TLD 100) and a dog phantom made with a plastic container, proportional to the dog size, fulfilled with water.

Keywords: LiF:Mg,Ti, TL dosimetry, radiology veterinary

1. INTRODUCTION

The reasons for using radiation in veterinary medicine are to either obtain optimum diagnostic information or to achieve a specific therapeutic effect while maintaining the radiation dose to the veterinary staff and the general public as low as reasonably achievable (the ALARA principle). Similarly it is also important to avoid all unnecessary irradiation of the animal patient (NCRP-148, 2004).

The primary goal in veterinary radiography is to produce radiographs of diagnostic quality on the first attempt. This goal serves three purposes: (1) to decrease radiation exposure to the patient and veterinary personnel; (2) to decrease the cost of the study for the client; and (3) to produce diagnostic data for rapid interpretation and treatment of the patient (Lavin, 2007).

The majority of our information on the exposure and effects of radiation relates to has been obtained to serve the needs of the radiological protection of human beings. Similarly much of our information on the behavior, effects and distribution of man-made radionuclides in the environment has also been derived to meet the needs of human radiological protection. It is necessary that a system for radiological protection of non-human organisms be harmonized with the principles for the radiological protection for humans (ICRP-91, 2002).

It has been reported that in some exams of thorax the dose received by the patient can vary between 0.43 mGy and 4.22 mGy, depending on the dog's size (Veneziani et. al, 2010)

This study aimed the evaluation of entrance surface-skin?? doses in dogs submitted to radiodiagnostic procedures of abdomen using the technique of thermoluminescent dosimetry (TLD). The radiation doses were measured using thermoluminescent dosimeters of lithium fluoride doped with magnesium and titanium (LiF:Mg,Ti) produced by Harshaw Chemical Company and a dog water phantom.

2. MATERIALS AND METHODS

2.1-Dosimetric material

A batch of one hundred of LiF:Mg,Ti (TLD-100) dosimeters produced by Harshaw Chemical Company were previously selected with repeatability better than $\pm 5\%$ and calibrated using ^{60}Co gamma radiation were used to doses evaluation. The pre-irradiation heat treatment adopted was one hour for 400°C in the furnace Vulcan model 3-550 PD and two hours for 100°C in the surgical heater Fanem model 315-IEA 11200. The LiF:Mg,Ti dosimeters were separated in plastic badges of ten dosimeters.

2.2-TL dosimeters irradiation

All the radiographic investigations were performed in the Hospital Veterinário Dr. Halim Atique of the Centro Universitario de Rio Preto (UNIRP) in the city of São José do Rio Preto, Sao Paulo state. Each procedure was carried out by the acquisition of radiographic images of abdomen: one latero-lateral and sometimes one ventro-dorsal of dogs with suspect of foreign body ingested.

Ten exams of abdomen's images of different dog's breeds were monitored. During the exams were measured the thicknesses of the two projections (latero-lateral and ventro-dorsal) and the distance of X-ray source to surface of animal patient.

According to the animal size (small, medium or large) it was adjusted the size of the radiation field to acquire the abdomen image. Values of the kV and mAs were also taken for each image; these values were used for the simulation of the dogs' irradiations of each investigation procedure. It is important to point out that the dosimeters were stored into a lead shield before and after the radiation exposure aiming to avoid any unnecessary exposure to external light, thus providing more accurate measurements. The parameters of the X-ray machines and its specifications are shown in Table 1.

Table 1 – Dosimetric material and specifications of the X-ray machines used in the irradiations.

Material	Composition	Dimensions		
	TLD type			
Dosimeter	LiF:Mg,Ti (TLD 100)	3.15 x 3.15 x 0.9 mm		
Irradiation's System	Radiation quality	Effective energy (keV)	kV	mA
X-ray machine Raicenter (UNIRP)		17.50	50	100
X-ray machine Pantak/Seifert (IPEN)	RQR3	27.15	50	10

After all data's acquisition the simulations of dogs' irradiations were performed with the same X-rays device and the dog phantom, assuring the reproducibility of all parameters mentioned before. The dog phantom consisted of a plastic container filled with water and it was positioned in the center of the table allowing the correct adjustment of the light field with the area of the plastic badges which containing the LiF:Mg,Ti dosimeters. Afterwards the dosimeters were sent to the Instituto de Pesquisas Energeticas e Nucleares (IPEN/CNEN-SP) in order to evaluate the doses and further analysis of the results.

2.3-Dosimeters's calibration

The irradiations of the dosimeters for obtaining the calibration curve were performed in the Laboratory of Instruments Calibration of IPEN (LCI – IPEN) with the X-rays machine used for radiodiagnostic device and the dog phantom proportional to the dog size, constructed for this finality.

In order to obtain the dose-response curve it was used ten dosimeters of LiF:Mg,Ti for each of the following dose values: 1, 2, 5, 10 mGy (Figure 1). The irradiation control, beam energy (kV), as well as the irradiation time to obtain the desired doses was done by the program "*Lab VIEW 7.0*". The water phantom was correctly positioned and the field size was adjusted with the LiF:Mg,Ti dosimeters in a way to guarantee the reproducibility of the radiographic images acquisition.

2.4-TL reading

After the irradiations, the thermoluminescent responses were evaluated using a thermoluminescent reader *Harshaw* model 4500. All measures were carried out 24 hours after irradiation.

3. RESULTS

Figure 1 presents the dose-response curve that was obtained to LiF:Mg,Ti dosimeters. Using the dose-response curve and its linear fitting equation shown in Figure 1, it was possible to estimate the entrance surface-skin doses of the animals for each radiographic investigation performed. It can be observed the linear behaviour in the dose range studied, from 1 to 10 mGy.

The dogs were divided into three groups according to animal size: small (5), medium (4) and big (1) dogs. Figure 2 presents the doses of the dogs according to procedure monitored.

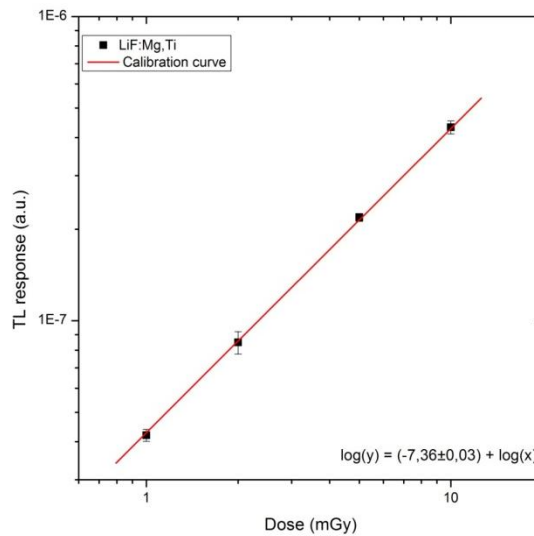


Figure 1 - TL dose-response curve of LiF:Mg,Ti dosimeters.

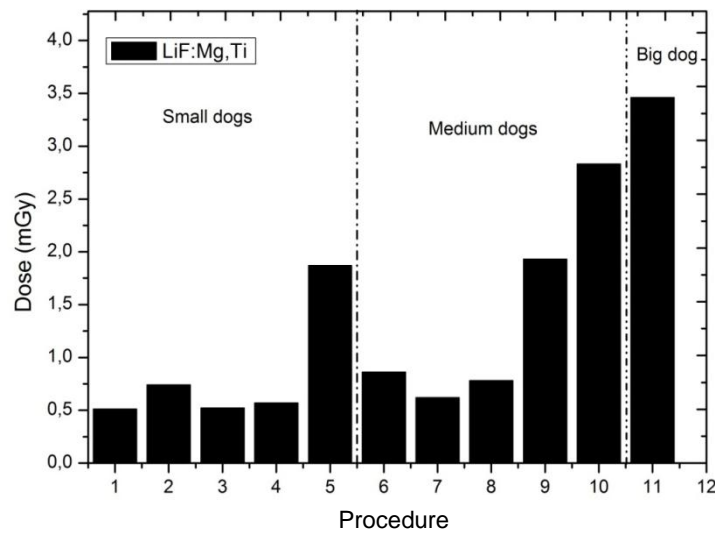


Figure 2 - Entrance surface-skin doses received for small, medium and big size dogs submitted to abdomen's X-rays to check foreign body.

4. DISCUSSION

Five procedures were carried out for small dogs and the average dose was 0.84 mGy, where the minimum dose was 0.51 mGy and the maximum dose was 1.87 mGy. This difference comes from the necessity of repetition of the imaging procedure since it is difficult to control the animals' movements.

The average dose for the four medium size dogs was 1.40 mGy, where the minimum dose was 0.62 mGy and the maximum dose was 2.83 mGy. It can be noticed an increase in the dose values compared to the small size animals. The analysis of the results showed that when a procedure didn't need repetition, the big animals received a dose higher than the small animals, but in some cases this is not true. In the procedure 5 (for small dog) the dose received by a small animal was higher than procedures 1, 2 and 4 (medium dogs), because it was necessary more repetitions.

The main problem of the veterinary radiology is the dose increase due to repetitions, this happens as a consequence of the difficulty of immobilize the animal.

5. CONCLUSIONS

The obtained results has shown to be extremely important the assessment of the doses involved in veterinary diagnostic radiology, also opening up new discussions about the importance of animal's cares, as currently spending on pet has grown significantly. A quality-assurance program should be established that ensures good image quality from a reasonable and acceptable radiation dose. New procedures can be developed aiming to reach a good quality image exam maintaining conditions safe of radiological protection to clinical staff and animal patients.

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