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Development of Object Simulator for Radiation Field of Dental X-Rays

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Abstract. In dentistry radiography is of fundamental importance to the dentist can make an accurate diagnosis. For this it is necessary to pay attention to the radiological protection of both the professional and the patient and control image quality for an accurate diagnosis. In this work, quality control tests were performed on X-ray machines in private dental intraoral in the municipality of Marabá, where they measured the diameters of the radiation field to see if these machines are in accordance with the recommendations, thus preventing the patient is exposed to a radiation field higher than necessary. We will study the results of each X-ray machine evaluated. For this we created a phantom to assess the size of the radiation field of X-ray dental, where we measure the radiation field of each device to see if they are in accordance with the recommendations of the ordinance No. 453/98 – MS.

1. Introduction

Many researchers from Brazil and around the world have published studies on radiological protection and the result of these studies, were created radiological protection standards and standardization body such as the International Atomic Energy Agency (IAEA), the TECDOC-796, published in 1995, which radiation dose is in radiodiagnosis and methods for its reduction [1].

Another document was published IAEA by the International Code of Practice for Dosimetry in Radiodiagnosis in 2007 [2]. Besides the IAEA has the International Commission on Radiological Protection (ICRP) founded in 1928, is considered the benchmark for many countries for the development of guidelines for radiological protection [3].

In Brazil the set of rules governing the operation of the radiology services is specified in ordinance No. 453 of the Ministry of Health - Brazil, dated 01/06/1998 - MH [4].

This ordinance was supplemented by resolution No. 64 of the National Health Surveillance Agency (NHSA) [5] and the document medical radiology: Safety and performance equipment [6].

These documents were established test parameters for execution quality beam radiology and proper criteria to be taken into account for assessing of the conformity equipment [7].

Services that work with radiology medical and dental care to comply with the specifications of ordinance No. 453/98 should do periodically for quality control analysis of radiological parameters. The evaluation of these parameters directly helps in control of radiology equipment.

The radiation dose received by the patient is linked to appropriate quality control and quality of a diagnostic x-ray beam. This dose should be reduced without loss to obtain the radiographic image.

Moreover, the major goal of radiation protection requires that: "The occupational exposures and public exposures arising from diagnostic radiology should be optimized to a value as low as practicable"[4].

1.1. Phantom

The phantom was created with the intention of using it in testing quality control of X-ray machines, of the training professionals and also to assess the overall quality of images for accurate diagnosis.

This testing tool has the function of reproducing characteristics of human tissues or organs in routine dosimetric in procedures radiology.

In phantom can also be introduced human tissues or organs. These phantoms, as well as help in the quality control of X-ray equipment, also assist in the training of professionals.

You could say that the phantoms are classified into: Phantom dosimetric Calibration Phantom and Phantom Image Anthropomorphic all tests used in quality control equipment, dosimetry and training professionals.

1.2. Radiation field

The radiation field of X-ray equipment should be limited (collimated) to the region of interest of the diagnosis. In apparatus for dental intraoral radiography is a diaphragm which limits the size of the radiation field to which the patient is exposed, the diaphragm is composed of a lead sheet with a central hole, trapped in the head tube.

Besides being limited by the diaphragm, the field size is also limited by a collimator, which is generally cylindrical; 20 cm in length approximately, consists of lead coupled to the head.

The first diaphragm is to limit the radiation beam being located near the exit of the X-ray tube. The collimator further limits the beam after its passage through the diaphragm.

In intraoral images the radiation field must have a maximum diameter of 6 cm at the output end of the collimator. The collimator must have a minimum length that varies from: 18 cm equipment to peak voltage less than or equal to 60 KVp, 20 inch voltage to between 60 and 70 KVp, 24 inch and if the voltage is greater than 70 KVp [4].

1.3. Radiographic film

The following certain standard radiographic films for its production, a pattern which "consists of a thin layer to the plastic base coated with a radiation sensitive emulsion. This emulsion comprises grains of silver bromide (AgBr) suspended in Gelatine "[8].

This emulsion has the function to absorb radiation during exposure to X-rays and produce a latent image, after developing, is transformed into radiographic images. As the grain silver bromide (AgBr) are more sensitive to radiation than visible light, then the dental X-ray films must be protected from light. Within the plastic base lead plate there is positioned one behind the film which has the function of reducing the dose to the patient.

The objective of this study is the evaluation of dental X-ray machines in eleven offices in the city of Maraba/PA.

It is noteworthy that the main objective of this work was to develop a phantom to assess the size of the radiation field of dental x-ray.

It is worth noting that the measures radiation field must be in accordance with ordinance No. 453/98/ MH, and the intraoral images, the size of the radiation field should not be more than 6 cm in diameter.

2. Materials and Methods

For the development of a phantom radiation field dental, we used raw materials and low cost dental use (Figure 1), which serve as support for the alignment of radiological films and to measure the diameter of the radiation field of dental x-ray.

For the cast of phantom test radiation field was used alginate to mold 4 movies together, forming a rectangle, to extract the mold of films together, put up the alginate films and over with the plastic and without protection. After the mold was applied to the self-curing acrylic, a 2:1 ratio of acrylic and liquid (Figure 1). The dimensions of the phantom is 9 x 11 x 1 cm^3 (external) and 8.2 x 6.2 x 0.5 cm^3 (internal).

In the tests we used the phantom and in it were inserted radiographic films. Subsequently the films were subjected to X-ray exposure of after exposure, the film was removed for revelation in a darkroom.

In the revelation of the films used to the Kodak brand and solution development time of the films in most offices were 1-2 minutes, and the office D which took more time for the revelation of the films taking 3 minutes to reveal them. But that does not harm or damage the film developed.

Figure 1. Phantom for the radiation field.

To measure the size of the radiation field of each X-ray equipment was analyzed according to the limit recommended by the ordinance No. 453/98 of the Ministry of Health/Brazil, acceptance limit of 6 cm and allowed ± 0.5 cm. For this, the four periapical films were aligned in phantom radiation field and directly exposed to the primary beam. We can see this in Figure 2.

Figure 2. Films lined up for evaluation of the radiation field

After development, the films were positioned and aligned on the phantom to measure the size of the diameter with a ruler of the field represented in Figure 3.

Figure 3. Measuring the diameter of the radiation field of the films revealed

3. Results and Discussion

According to tests conducted to assess the efficacy of phantom radiation field and in possession of the results obtained, it was observed that the phantom showed good results for the measurements of the radiation field.

After analysis of the phantom tests conducted in eleven X-ray equipment, it was observed that most of the equipment is within the standards recommended by NHSA.

Already equipment or X-ray equipment (E and M) whose sizes were measured radiation fields, respectively 7.0 cm and 7.3 cm, are releasing a radiation area larger than necessary to the image diagnosis which results, or are above the levels recommended by NHSA, thereby causing an increase in the absorbed dose in relation to patients and medical professionals.

Another aspect that needs attention is that some X-ray equipment also had a diameter of the radiation field smaller than 6.0 cm. The equipment (5.6 cm) and L (5.5 cm) below are recommended by NHSA. The results of the test radiation field using the phantom are detailed in Table 1.

Table 1 - Results of tests for measuring the diameter size of the radiation field.

Equipment	Radiation Field Measurement (cm)
A	5,6
B	6,0
C	6,0
D	6,0
E	7,0
F	5,6
G	6,0
H	7,3
I	6,0
J	6,0
L	5,5

It is noteworthy that the largest diameter field radiation found in X-ray equipment was the equipment H (7.3 cm), field diameter greater than recommended by the ordinance No. 453/98.

For information purposes, the revelation of the films was used a darkroom red and the eleven and portable X-ray equipment evaluated, four of them were to trigger analog equipment (devices D, E, F and I).

6. Conclusion

From the field test conducted in radiation X-ray equipment Maraba/PA, it can be concluded that the majority of dental X-ray equipment is within the standards of ordinance No. 453/98.

Thus, it can be seen that the percentage corresponding to 81.8% within the recommended standard of quality.

The phantom radiation field efficacy tests showed and proved how important helper for the correct positioning of film radiographic film used in dental radiography.

Thus presents itself as a safe method for testing and field measurements of radiation for dental X-ray machines.

This phantom, unlike the constituent material of the phantoms used in these tests may be made with good quality raw material and low financial cost, may be a good alternative for the quality control of these devices.

From these studies we will begin the program of quality control in Maraba/PA following the rules of NHSA. This is a very important step for the correct application of the conditions related to radiological protection both for professionals working in the field of radiology, as the population of Maraba/PA and the northern region of Brazil.

Here, we will expand our field of study with respect to diagnostic imaging which will best prepare, retrain and guide professionals on standards NHSA for quality control of equipment and images and also on the implementation of standards and legislation on radiological protection in force in Brazil.

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