

DEVELOPMENT OF PHANTOM PERIAPICAL FOR CONTROL QUALITY

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ABSTRACT

This study aimed to develop a dental phantom with cysts for evaluation of periapical radiographs that was tested in private dental offices in the city of Marabá, northern Brazil. Through some tests with the object simulator (phantom) were obtained 12 periapical radiographs (one in each of the offices visited) that waking up to the standards of Ordinance No. 453 were visually evaluated by observing the physical parameters of exposure (kVp and mA), time revelation of the radiographic film, later the other radiographs were visually compared with C6 ray set as the default. Among the results, it was found that only two of the twelve rays cysts could not be viewed and, therefore, these two images were deemed unsuitable for accurate diagnosis in the 10 images the cysts could be displayed, however according the images have different qualities comparisons. In addition, it can be concluded that the performance of the phantom was highly satisfactory showing to be efficient for use in quality control testing of dental X-rays, the quality control of radiographs and continuing education of dental professionals for a price much more accessible.

1. INTRODUCTION

In recent years, the use of radiation has become increasingly important in medicine, industry and other activities, no different immeasurable its importance in dentistry. The main aim of the use of radiation in dentistry is to produce correct clinical diagnosis based on the analysis and interpretation of radiographic images. Therefore, the effectiveness and success of the X-rays are contingent on obtaining good quality images [1, 2].

Thus, to ensure the predominance of benefits and protection on the use of radiation in medicine and dentistry, on June 1, 1998, the Secretariat of Health Surveillance, Ministry of Health of Brazil issued Ordinance No. 453 [3], which deals with the "Basic Guidelines on Radiological Protection in Medical and Dental Radiology". In fact, where are certain standards to be followed in the use of radiation. Given the parameters set forth in this ordinance, an alternative to the quality control of dental X-ray apparatus of radiographs processed in these devices and the continuing education of dental professionals is using physical phantoms, phantom known as the exposure of individuals radiation in order of studies is not justified [3], made more relevant the use of phantoms for carrying out the quality tests.

In this sense, the objects dental simulators have several applications, among these, the assessment of quality of radiographs processed in offices, assists in the development of radiation protection programs and quality control of dental X-ray machines, according to rules established by Ordinance No. 453 [3], where the phantoms should be used for testing in order to improve the image quality of medical and dental diagnostic radiology services, having as main objective the reduction of exposed radiation doses to patients without impairing quality of the examination.

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The dental phantom with cysts developed was used as affordable alternative and effective through visual assessment of radiographs, in the case of this study were evaluated periapical radiographs processed in private dental offices in the city of Maraba, in Para State, Brazil. However, we attempted to evaluate the physical parameters used in the processing of X-rays in these offices and the radiographs can provide an effective diagnosis by identifying the presence of cysts on x-rays, assessing its final quality as well as according to quality parameters already predetermined.

2. METHODOLOGY

The dental phantom was developed with similar density material of the human body in order to represent this feature in radiography based on the phantom developed [3], however some modifications were made in the structure. To make the phantom was used alginate and self-curing pink acrylic, both of dental use, to obtain the composition of the region where the tooth was packed.

For the preparation of alginate, was followed the manufacturer's instructions by adding water in the proportions recommended on the packaging material so that the stay pasty texture. After preparation of the folder, it was immediately used for the molding. With this material were prepared molds in the shape of three boxes with room for placing the wax, the tooth and the radiographic film. After obtaining the molds alginate, pink self-curing acrylic VipiFlash mark, was prepared by mixing the polymer (powder) and the monomer (neat) in volume ratio recommended by the manufacturer; 2.0 parts to 1.0 parts polymer monomer. The resulting compound of the mixture was distributed in the form of alginate with the box geometry.

During the entire preparation process, the temperature of acrylic remained near 25°C. Fig. 1 and 2 shows the acrylic plates overlap in order to form the phantom, where each of the three plates comprising the phantom has the following dimensions: 08 cm square and 01 cm are also marked with cysts placed near the tooth representing calcifications possible to scan X-rays. Fig. 3 shows the overlay layout of the three acrylic sheets as was used in testing; including showing the face that expose the tooth is facing downwards.

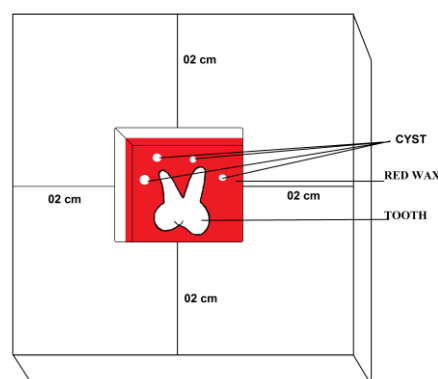


Figure 1 Representation the phantom with cyst, red wax and tooth (plaque superior).

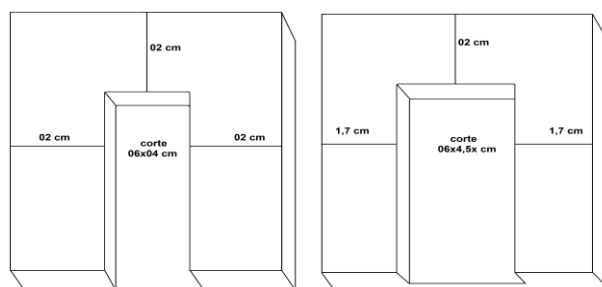


Figure 2 Representation the phantom (plaques bottom).

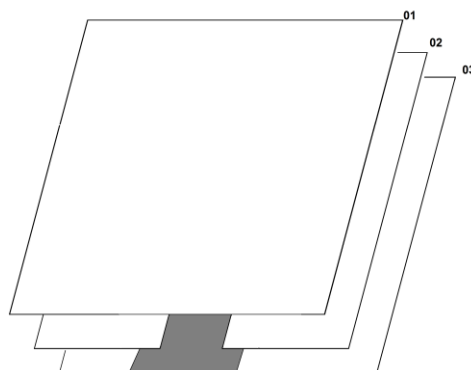


Figure 3 Representation of the stacking order of acrylic plates was used during the tests with the phantom.

For producing the cysts of different diameters placed at the back tooth, glass powder were used, the liquid acrylic and acrylic powder, because mixing these materials acquired a density which resembles the characteristics of possible dental anomalies called calcifications that appear on radiographs as a radiopaque image resembling the image of the tooth. Fig. 4 show the stacking order of acrylic plates was used during the tests with the phantom.



Figure 4 Representation of the stacking order of acrylic plates was used during the tests with the phantom.

For the evaluation of the dental phantom were performed tests on 12 private dental offices of Maraba, in Para State, where the following brands dental X-ray machines were found: 70x Electronic Spectro - Dabi Atlante (70 kVp, 8 mA); Spectro70x - Dabi Atlante (70 kVp, 8 mA); GNATUS (60 kVp, 10 mA); GNATUS (66 kVp, 6.5 mA); Procyon (70 kVp, 8 mA); to perform the tests in each office was asked to professional who exposed the phantom to radiation analogous to the periapical radiographic examination is performed with a patient to the conventional method (exposure, development, cleaning, fixing and drying).

Note that was asked to work to maintain the focus-surface 05 cm and the collimator positioned parallel to the phantom so that it is parallel to the tooth and the film as shown in Fig. 03. In each office we used a Kodak type E, which was later revealed by professional dentistry in private practice in accordance with its routine method, respecting the time of exposure, developing and fixing in accordance with the requirements of Ordinance N°. 453 [3]. After the acquisitions of 12 radiographs were evaluated both also under the rules of Ordinance N°. 453 analyzing the physical parameters used to acquire the images obtained by the dental phantom with cysts.

3. RESULTS

The results of the tests were performed with the phantom, in twelve (12) dental X-ray machines in private clinics in the city of Maraba from October 2014 to February 2015, as well as evaluating the quality of periapical radiographs processed in these offices will still be shown that the physical parameters were taken into account in the assessment and discussion of the results obtained in this work.

The phantom was tested on different devices of dental X-rays, being subjected to different radiation exposure times enabled the acquisition of radiographs with details and distinct qualities, however it can be seen that the phantom is very well the characteristics of the simulated region and is resistant to exposure to X-rays, it does not suffered perceptible to the unaided eye changes in their structures, namely, there was no change in colour or stiffness of the object or after testing.

According to Ordinance Nro. 453 [3], to ensure the quality of radio diagnosis and keep the radiation protection requirements in diagnostic imaging procedures should be the laying of tests and evaluations carried out and the results achieved in this way, will be described herein which parameters were used and evaluated in each of the 12 tests performed with the tooth phantom will be developed and presented the results from the evaluation of the images as the images are the end result of each test.

Taking into account the physical parameters of the tube kVp, nominal current, exposure time and time in the developer, 12 radiographs were visually compared with each other in order to verify the differences in the quality of each one, considering they refer to different dental X-ray machines were obtained images with very different qualities of images that enable a good view of the cysts to images in which the cysts are not observed. Fig. 5 shows the images positioned beginning of scale clearer radiography (C1) to the darkest ray (C12), was also identified the image with the best quality acquired within the standards established by Ordinance No. 453 [2], and this so-called standard image comparisons were made with the other. For purposes of information the n 01 (cyst simulator 1) and n 02 (cyst simulator 2) respectively.

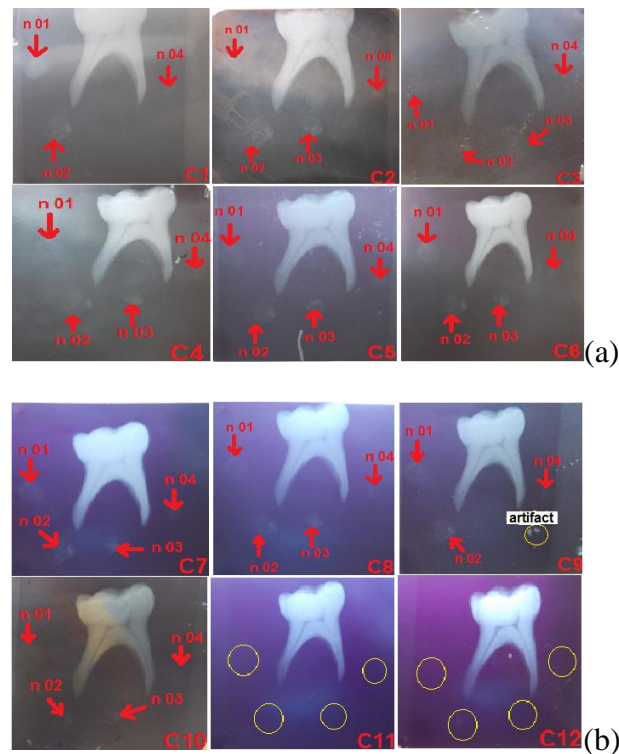


Figure 5 Representation images obtained with the tooth phantom (A and B)

The image set as default among the 12 radiographs acquired the image was identified as C6 (Figure 5) because it introduces, among others, the best quality and the contrast between the radiopaque parts (the tooth and calcifications) and the part of the object that simulates the soft tissue wrapped the tooth, there is excess brightness compared to the others was considered an image with high density, it is dark, however, as to the resolution of this image was possible to have a great view of the cysts and consequently based the image to be making an accurate diagnosis.

From the standard image C6 was verified that in the remaining images obtained was possible to visualize the cysts with these comparisons, it became clear the distinction between all images. The physical parameters used to acquire each of the X-ray tube voltage related to the nominal current of the dental X-ray apparatus and exposure times, and disclosure are placed on table 1, where the images are represented by the letter C followed by a number that indicates the order of the lighter ray (C1) to the darker (C12), as shown in Figure 4.

Table 1 Presentation of physical parameters to obtain the images

Image	Tube Voltage (kVp)	Nominal Current (mA)	Time Exposure (s)	Time Tilling (s)
C1	70	09	0,40	06
C2	70	08	0,60	15
C3	70	08	0,80	40
C4	70	08	1,50	30
C5	70	08	0,50	50
C6	60	10	0,80	05
C7	60	10	0,80	10
C8	70	08	1,50	50
C9	70	08	0,40	60
C10	70	08	1,20	10
C11	70	08	0,80	60
C12	70	09	0,60	20

Several factors can affect the quality of a radiographic image, thus evaluated the parameters that most certainly contributed to the quality of the images obtained in the tests with phantom.

According to Table 1, in 83% of the voltage X-ray machines in the tube is 70 kVp, 17% of the devices is 60 kVp, it was found that all the equipment used had a higher voltage than 50 kVp, agreeing with the Ordinance No. 453 recommends that oral radiographs tension in the tube is greater than or equal to 50 kVp, the rated current to operate these devices ranges from 8 to 10 mA. These kVp and mA values and the exposure and development time values varied widely among the studies which explain the differences in quality of the images acquired and then evaluated visually.

According to Table 1, the C3 and C11 radiographs were obtained in X-ray machines that operate with the same voltage and rated current in both the phantom tests was spent for the same period, however, the time difference in the developer caused the obtaining two totally different images where the image C3 have a light ray with low contrast and low density, but allows visualization of the cysts, image already C11 was 20 s longer in the dark and left developer does not allow the visualization of cysts.

Comparing the C1 and C12 images were obtained in devices with the same voltage and rated current, we respectively, the first to which less time exposure and development leading to a very clear image with little density, since the second exposed to more exposure times and revelation is an image is dark, it was not possible to display the cysts.

The images C2, C4, C5, C8, C9 and C10 were acquired on similar X-ray apparatus (with the same voltage and the same rated current), but were obtained in different offices and performed by professionals using different exposure time and revelation according to routine examinations, taking into account besides these two times of the developing solution

characteristics (had been much or little used), as this influences the resulting image. It may be noted that the major distinction among the six images mentioned above, concluded that these two times have a significant influence on each of the images.

Finally, C6 and C7 images, obtained in a similar apparatus, but at different offices that agreement, it was found that the 5 seconds of more exposure image obtaining made a difference C7, C6 for the image was defined as optimal for effective diagnosis and C7 since the image was darker (probably due to the amount of time the developing solution) which does not allow good visualization of the cysts.

Comparing all other images with the image C6 found that only the C11 and C12 images would not be useful in diagnosis, as these images are not allowed to cysts of the display to be very dark images. You can also verify that the non-uniformity in the images obtained, it should be to different parameters and found that even for devices with the tension on the tube and the same rated current images obtained with different quality indicating that the radiation exposure time radiographic film and the time that the film is in the developer are great contribution to the observed result in the final image.

Images acquired with the phantom showed satisfactory results, enabled the cysts view with phantom and perform inter comparison of the physical parameters as well, namely the inter comparison of images taken in dental X-rays. Furthermore, the phantom can be used for the training of dental professionals, to obtain quality images, reducing the patient exposure to unnecessary radiation.

4. CONCLUSION

Based on the results achieved in this study, we applied based and work methodology employed sequentially analyzed, it can be concluded that the quality of periapical radiographs taken with the phantom in private dental offices in Maraba are mostly satisfactory the achievement of an efficient possible diagnosis.

Despite the visual assessment is neither the only nor the best way to review for an accurate diagnostic radiology this is the form of assessment most used in daily dental offices visited. In the case of professionals who used a longer expo-sure time and less time in the developer might be using less exposure time and more time in the developer, freeing the patient from exposure to unnecessary radiation.

As for the phantom there has been a satisfactory performance on memory tests. Also according to the results of the survey, it is noticed that the simulations can contribute significantly in the continuing education of dental professionals. Through the study analyses the images of physical parameters are possible, such as the geometry of the tooth and possible malfunctions, such as the cysts.

However, even if the industrial processes for the production of dental phantom proposed here represent a significant increase in the total financial cost to the industrialization of the phantom, of course you can play multiple copies a relatively low financial cost.

5. REFERENCES

1. Bushong, S. C. *Radiologic Science for technologists* 9ª Ed. Elsevier, 2008.
2. White, S. C.; Heslop, E. W.; Hollender, L. G.; Mosier, K. M.; Ruprecht A, Shroust M K. Parameters of radiologic care: an official report the American academy of oral and maxillofacial radiology *Org. Surg.* Vol. 91 nro 5, pp.498-511, 2001.
3. Brasil Ministério da Saúde. Diretrizes de proteção médico e odontológico Portaria 453.1 de junho de 1998 MS/SVS at <http://www.phymed.com.br/fisica-medica/site/textos/portaria453.PDF>, 1998.
4. Silva, P. V. R.; Costa, R. R.; Silva, M. C.; Iwaki, L. C. V.; Takeshita, W. M. Digital evaluation of the influence of interruption of the fixation process on radiographic contrast and base-plus-fog density in three commercial brands of radiographic films *Rev Odontol UNESP.* Vol 43, nro ,1 pp.41-45, 2014.
5. Miles, D. A.; Vandis, M. L.; Razmus, T. F. *Basic principles the of oral and maxillofacial radiology.* Philadelphia:W.B, Saunders, 1992.
6. Belinato, W. Avaliação de parâmetros físicos em radiologia odontológica de consultórios públicos de Sergipe. Dissertação de mestrado Universidade Federal de Sergipe, 2010.