JOURNAL OF APPLIED ORAL SCIENCE
www.fob.usp.br/jaos or www.scielo.br/jaos
J Appl Oral Sci. *2008;16(5):350-4*

EVALUATION OF THE EFFECTS OF PROCESSING DELAYS AND PROTECTIVE PLASTIC CASES ON IMAGE QUALITY OF A PHOTOSTIMULABLE PHOSPHOR PLATE SYSTEM

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Received : October 03, 2007 - Modification : January 28, 2008 - Accepted : May 07, 2008

ABSTRACT

This *ex vivo* study evaluated the quality of digital radiographic images obtained with the photostimulable phosphor plate system (Digora) according to the processing delay and maintenance of optical plates in either opaque (supplied with the system) or transparent protective plastic cases during this period. Five radiographs were obtained from the mandibular molar region of a dry human mandible using optical plates. These plates were placed in the protective plastic cases before obtaining the radiographs and were processed immediately or after processing delays of 5, 60 and 120 min, when the case was removed. The results revealed a reduction in image quality when processing was delay 120 min compared to the other times. The opaque case provided better protection to the sensor than the transparent case. In conclusion, a 120-min processing delay for the Digora system caused a reduction in image quality, yet without interfering with the quality of diagnosis. The opaque case supplied by the system's manufacturer provided better protection to the optical plate than the transparent case.

Key words: Radiography. Digital images. Phosphor storage plates. Digora.

INTRODUCTION

Digital radiograph or radiovisiography was first described in 1987 and was commercially introduced by *Trophy Radiologie* in collaboration with Mouyen[12] in 1993. Three systems are employed for radiovisiography: the CCD sensor (Charge-Coupled Device), CMOS sensor (Complementary Metallic Oxide Sensor), and PSPs (PSPs – Phosphor Storage Plate – optical plate); the latter includes the Digora, Digident, Denoptix and Den Ortix systems[11]. Some studies have found better outcomes of digitized images for endodontic diagnosis and treatment[5-9,13,15-18].

However, some doubts remain in the use of radiovisiography based on the optical plate system as to the durability of the plate[3], image quality according to the processing delay[1,2,14], and storage conditions[10]. No study has yet investigated the influence of utilization of opaque cases on the quality of digital image.

This *ex vivo* study evaluated the quality of digital radiographic images obtained with the Digora system according to the processing delay and maintenance of optical plates in either opaque (supplied with the system) or transparent protective plastic cases during this period.

MATERIAL AND METHODS

The study was conducted on a dry human mandible fixed on an acrylic resin base. A plastic tube was fixed frontally to the mandible to standardize the position of the X-ray source, thus standardizing the vertical and horizontal angles (Figure 1). A groove was prepared on this resin base to standardize the position of the optical plate.

Radiographs were obtained from the mandibular molar region by utilization of optical plates with an x-ray unit (Gnatus model XR 6010; Gnatus, Ribeirão Preto, SP, Brazil)

FIGURE 1- Mandible on acrylic base for standardization of x-ray incidence angle and position of the optical plate

FIGURE 2- Transparent and opaque plastic cases for the optical plates

set at 60 kVp and 10 mA, with open tube, total filtration of 1.5 mm Al, exposure time of 0.3 s, and optical plate of the Digora system (Soredex, Orion Corporation, Finland). Two groups were constituted for x-ray exposure: in group A, the optical plate was inserted and sealed in the opaque plastic case supplied by the manufacturer and kept as such until processing; in group B, the optical plate was stored in a transparent plastic case (Figure 2). Five optical plates were exposed for each period of processing delay.

The optical plates were processed in the Digora scanner

immediately and 5, 60 and 120 min after X-ray exposure, and were transferred to the computer for analysis of digitized images. Analysis was performed directly on the computer screen by three examiners using the Digora for Windows software. The images were analyzed as to brightness, contrast and resolution of tooth structures (enamel, dentin, root and pulp cavity) and periapical structures (periodontal space, cortical bone, alveolar bone), which received scores 0 to 2, as follows: 0- Poor image quality; 1- Good image quality; 2- Excellent image quality.

Data were submitted to the Kruskal-Wallis non-parametric test, and comparison of results between opaque and transparent cases were submitted by the Mann-Whitney test. Significance level was set at 5%.

RESULTS

Table 1 presents the scores assigned by examiners to the images, according to processing delays and utilization of opaque or transparent plastic cases.

There was statistically significant difference ($p<0.05$) regarding the processing delays, namely immediate, 5 and 60 min with utilization of opaque case (Table 2). This difference was observed between the 120-min delay and the other periods (Table 3). No statistically significant difference ($p>0.05$) was observed among processing delays with utilization of transparent case (Table 4). Comparison of results between opaque and transparent cases did not reveal significant differences ($p>0.05$) (Table 5).

TABLE 1- Scores (0 to 2) assigned to radiographic images (1 to 5) by examiners (I, II and III), according to the type of plastic case (A-opaque and B-transparent) and processing delay (min.)

		Processing delay (min)																			
		Immediate Images					5 Images					60 Images					120 Images				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
A																					
Opaque	Examiner I	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	1	1	1	2	2
case	Examiner II	2	2	2	2	2	2	2	2	2	1	2	1	2	2	1	1	1	1	2	2
	Examiner III	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2
B																					
Transparent	Examiner I	2	2	2	2	2	2	1	2	2	2	2	2	2	1	2	0	1	0	1	2
case	Examiner II	2	2	2	2	2	2	2	1	2	2	2	2	2	1	2	2	0	1	0	2
	Examiner III	2	2	2	2	2	2	1	2	2	2	2	1	1	2	2	2	1	0	1	1

TABLE 2- Kruskal Wallis test for analysis of the processing delay of optical plates protected with opaque cases

Processing delay	Median	Sum of ranks	Mean ranks	Number of values
Immediate	2.0	60.0	12.0	5
5 min	2.0	60.0	12.0	5
60 min	2.0	60.0	12.0	5
120 min	1.0	30.0	6.0	5

Hc= 10.05882; Chi-square with 3 degrees of freedom; Probability = 0.018072 (significant)

TABLE 3- Mann Whitney test for analysis of the processing delay of optical plates protected with opaque cases

Processing delay	Mean	Median	Sum of ranks	Mean ranks	Number
60 min	2.0	2	35.0	7.0	5
120 min	1.4	1	20.0	4.0	5

U=5.00000000;Exact probability = 0.150794; Normal approximation: Z=1.96396101; Probability = 0.04953461

TABLE 4- Kruskal Wallis test for analysis of the processing delay of optical plates protected with transparent cases

Processing delay	Median	Sum of ranks	Mean ranks	Number of values
Immediate	2.0	65.0	13.0	5
5 min	2.0	55.5	11.1	5
60 min	2.0	55.5	11.1	5
120 min	1.0	34.0	6.8	5

Hc= 5.164999; Chi-square with 3 degrees of freedom; Probability = 0. 160106 (non significant)

TABLE 5- Mann Whitney test for comparison between opaque and transparent cases used for protection of optical plates

Case	Mean	Median	Sum of ranks	Mean ranks	Number
Opaque	1.85	2.0	431.5	21.6	20
Transparent	1.70	2.0	388.5	19.4	20

U=178.5. Normal approximation: Z=0.83688636; Probability = 0.40265645 (non significant)

DISCUSSION

Digital radiography was introduced to dental practice with a view to replace the conventional radiography due to the shorter exposure to radiation, achievement of high-quality images, possibility of adjustments with aid of software, and comparable reliability to conventional radiography, for both endodontic diagnosis and treatment[3,5-7,19].

The main disadvantage of the optical plate system is the need of additional time for processing and possible loss of quality when the sensitized optical plate is exposed to light. Some authors have emphasized that, after exposure to x-ray, the optical plates should be processed within 1 h in order to avoid loss of image quality[1,2]. Other authors believe that the plates can be processed within 6 h if stored in appropriate cases[10].

In the present study, a processing delay of 120 min caused a mild reduction in image quality, yet without compromising the quality of diagnosis (Table 1). The three examiners were able to interpret radiographic details in all study periods. It should be highlighted that the images were not altered as to the brightness and contrast provided by the system, being analyzed as produced on the computer screen.

Together with the Digora system, the manufacturer supplies opaque plastic cases that offer protection against contamination and the deleterious effect of light. Images of optical plates maintained in the original opaque cases after exposure to x-ray maintained their image quality up to 120 min (Table 2), with significant difference between the 120-min processing delay and the other periods (Table 3). When the optical plates were maintained in transparent cases, there was also a progressive reduction of image quality (Table 1), which was more accentuated at 120 min (Table 4), though without statistical difference among periods. This is due to the fact that the optical plate protected with transparent cases is subjected to the continuous action of light, with progressive loss of image quality. However, images obtained with optical plates protected with both opaque and transparent cases and with processing delays of up to 120 min provided good quality for diagnosis.

CONCLUSIONS

The findings of the present study revealed that the processing delay of 120 min for the Digora system caused a reduction in image quality, yet without interfering with the quality of diagnosis. The opaque case supplied by the system's manufacturer provided better protection to the optical plate than the transparent case.

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