

Analysis of conventional and digital (digora) radiographic methods for identification of the mineralized barrier after pulpotomy in dogs

Estudo comparativo entre os métodos radiográficos digital (digora) e convencional para a identificação de barreira mineralizada após pulpotomia em dentes de cães

Giovana Calicchio CANOVA – MS

Rodrigo Cardoso de OLIVEIRA – MS

Everdan CARNEIRO – MS

Renato Menezes DA SILVA – MS

Endodontics Department - Bauru Dental School – USP, Brazil

Sérgio Henrique Staut BRUNINI

Post-graduation students – Endodontics Department - Bauru Dental School – USP, Brazil

Ariadne Machado Gonçalves LETRA – MS

Endodontics Department – Dental School – Rio de Janeiro – UERJ – Brazil

Orivaldo TAVANO

Titular Professor (retired) – Stomatology Department – Bauru Dental School – USP – Brazil

Clovis Monteiro BRAMANTE

Titular Professor – Restorative Dentistry, Endodontic and Dental Material Department – Bauru Dental School – USP – Brazil

José Carlos PEREIRA

Associated Professor – Restorative Dentistry Department – Bauru Dental School – USP – Brazil

José Mauro GRANJEIRO

Associated Professor – Biological Science Department – Bauru Dental School – USP – Brazil

ABSTRACT

The purpose of this study was to test the hypothesis that the digital radiographic method (Digora), when compared to the conventional radiographic method, allows better identification of the mineralized tissue barrier formed after pulpotomy in dogs and protection of the remaining pulp with a resorbable membrane of demineralized bovine cortical bone (Group I) and calcium hydroxide (Group II). Two dogs were used, according to the International Organization for Standardization, specification #7405:1997: one for a follow-up period of 7 days and another for the 70-day period. Ten teeth of each dog were submitted to pulpotomy, being 7 for Group I and 3 for Group II, resulting in sixteen treated roots for each period. Standardized procedures were used to obtain and analyze the conventional and digital radiographs. Radiographic images suggesting a mineralized barrier were only distinguished in the roots treated with calcium hydroxide; however, no agreement was achieved between four experienced observers. Concerning the comparison between the digital and conventional methods, a suggestive image of a mineralized barrier was observed in four and five roots, respectively, but only one such root belonged to the follow-up period of 70 days, when a dentin-like bridge was expected. In conclusion, the initial hypothesis was not confirmed.

KEYWORDS

Radiographic image enhancement; diagnostic imaging; radiographic interpretation; radiography dental; pulpotomy, mineralized barrier

INTRODUCTION

Radiographic examination is a very important tool in Dentistry, especially in Endodontics, where its application throughout the treatment and during the follow-up period is fundamental. However, due to its limitations such as the difficulty of three-dimensional visualization of the teeth and the possibility of superposing images, radiographs are considered a complementary exam, since the image presented is subjective.

In an attempt to enhance visualization and interpretation of the radiographs and therefore improve its diagnostic properties and reduce the number of repetitions, the radiation dose and the time required for achievement of the images through elimination of the chemical processing, new tools were developed for the creation of digital images, such as the Digora System. Introduced in 1994 by Soredex (Orion Corporation – Helsinki – Finland), this system employs a photo-stimulated phosphor plate that, similarly to the conventional film, is sensitized by the X-ray. The latent image produced by the X-ray is stored in the plate until digitization by a laser beam is performed in a proper system. The main advantage of this system is the reutilization of the plates by submitting them to a strong white light beam⁵.

Nevertheless, regardless of the radiographic method, either conventional or digital, the efficiency of the exam is directly related to its quality, conditions for its accomplishment, criteria established for the analysis and adequate experience of the examiner¹³.

Several studies in the dental literature have compared the digital and conventional radiographic methods^{3,4,7,8,12}, however, no studies were found concerning mineralized barriers formed after pulpotomy.

The purpose of this study was to test the hypothesis that the digital (Digora) radiographic method, when compared to the conventional method (periapical film), allows better identification of the mineralized tissue barrier formed after pulpotomy in dogs' teeth and protection of the root tissue with a resorbable membrane of demineralized bovine cortical bone (group I) and calcium hydroxide (group II).

MATERIAL AND METHODS

This research was developed according to the Brazilian College of Animal Experimentation (COBEA)².

Twenty teeth of two mixed-breed dogs were used for the study period of seven and seventy days. The dogs were anesthetized by means of an intramuscular injection of a combination of Levomepromazin (Neozine™ - Rhodia Farma) and Tiletamin/Zolazepan (Telazol™ - Fort Dodge Animal Health).

All procedures were performed according to the International Organization for Standardization (ISO) 7405:1997⁶. After placement of the rubber dam and asepsis of the field, pulpotomy was performed with round diamond burs in high-speed under continuous irrigation with distilled water. Hemostasis was accomplished after flushing the cavities with sterile 0.9% saline solution (m/v) and drying with sterile cotton pellets.

Ten teeth from each animal were used: mandibular thirdrd and fourthth premolars and firstst molars, maxillary canines and thirdrd incisors, randomly distributed among the groups. The pulp remnants of seven teeth were protected with a resorbable membrane of demineralized bovine cortical bone (Group I, Gen-derm™ - Minister of Health Registration #103.455.00007 - Baumer S.A., Mogi das Cruzes, SP, Brazil). The pulp remnants of the further three teeth were capped with calcium hydroxide P.A. (Group II, Biodinâmica™ - Biodinâmica Química e Farmacêutica, Ipirorã, PR, Brazil), mixed with sterile 0.9% saline solution.

The materials were protected with gutta-percha and the cavities were restored with the glass-ionomer cement Vitremer® - 3M (St. Paul, MN, USA), according to the manufacturers' instruction.

Euthanasia was performed by perfusion after the experimental periods. The mandible and maxilla were removed in block and submitted to radiography by two methods: the Digora, with photo-stimulated phosphor plates, and the conventional method, with Kodak Insight™ periapical films - Eastman Kodak Company (Rochester, NY, USA). A Dabi Spectro™ 70/10 X-ray source was used at 70 kV and 10mA, with a 50-cm distance between the focal point and the image sensor and an exposure time of 0.3 second for the phosphor plates and 0.6 second for the periapical films.

Digitization of the photo-stimulated phosphor plates was performed immediately after X-ray exposure on the software *Digora for Windows 1.51*. The radiographs obtained with Kodak Insight films were chemically processed by the time-temperature method in a dark chamber under controlled

illumination with Kodak solutions™ – Kodak Dental, Kodak (SP, Brazil). All images were evaluated and interpreted by four experienced professionals, being two endodontists, one radiologist and one restorative dentist, who did not know the material employed or the experimental period. They were asked to identify a suggestive image of a mineralized tissue barrier.

Analysis of the digital images was conducted in the same equipment used to capture the image. A PC compatible with *Windows 98* with a *Digora for Windows 1.51 software* was adjusted to each examiner, providing normal, negative and three-dimensional (3D) images.

The conventional radiographs were examined in a film viewer at 4X magnification in a darkened room¹³.

RESULTS

All examiners analyzed 32 roots, 16 for each experimental period. All images suggesting mineralized barriers were observed in roots treated with calcium hydroxide.

Only four roots showed a suggestive image of mineralized tissue barrier with employment of the Digora system. However, these roots were related to the follow-up period of seven days, when no dentin-like bridge was expected. There was no agreement between all examiners in any radiographs by this method (Table 1). There was no difference between the standard, negative and 3-D images for each root examined (Figures 1-3).

On the other hand, concerning the conventional radiographic analysis, five roots presented a suggestive image of mineralized barrier, but only one (distal root of the mandibular right first molar) corresponded to the seventy day period (Figure 4). Three of four examiners agreed on identifying this barrier.

DISCUSSION

Radiography is a very important complementary tool, mainly in endodontic procedures. Digital systems have been developed to improve the efficiency of this technique⁹. Several studies were conducted on root canal measurements, observation of the healing process of periapical lesions, and to estimate the working length. This work is the first aiming at the comparison between the conven-

tional and digital radiographic methods to detect the mineralized barrier after pulpotomy.

Four experienced professionals detected just one of three mineralized barriers in roots treated with calcium hydroxide. Surprisingly, the digital method failed to show the mineralized barriers at the follow-up period of seventy days. Another noticeable finding was the great number of false-positive identifications at the follow-up period of seven days.

Some studies demonstrate that digital radiography may be less sensitive in some cases^{4,15} especially due to its dimensions and steadiness. This difference may have affected the attempt to detect the formation of the mineralized barrier.

In 1980, Pereira et al.¹¹ conducted a microscopic and radiographic analysis of the behavior of dog dental pulps that were experimentally exposed and protected with calcium hydroxide paste or powder for 2, 30, 70 and 120 days. The authors verified that the mineralized barriers observed in the radiographs in almost all cases were not confirmed by the microscopic examination, indicating false positive results. This lack of association between the radiographic and microscopic findings was confirmed in a posterior study in most roots treated with calcium hydroxide¹¹.

Aragones¹, in 1992, performed a radiographic and microscopic investigation of the biological behavior of the dental pulp after pulpotomy and protection with microgranular hydroxyapatite. Newly formed barriers detected through the microscopic exam were not detected by conventional radiography.

According to Syrioupoulos et al.¹⁴ (2000), the ability of the observer is an important factor as to the variability of radiographic diagnosis, and not the method through which the image is obtained. When radiographic images and chemical processing are technically well done, the difficulty found to compare different radiographic methods relies solely on the operator, since interpretation of the images is always subjective. We did not face any difficulty in such aspect because the examiners in this study were extremely experienced and calibrated, as corroborated by the high number of coincident observations.

Nevertheless, due to the limitations of the radiographic technique and experimental procedures used in this study, the presence of mineralized tissue in the other roots at the follow-up period of seventy days cannot be discarded.

Our results did not support the initial hypothesis that the digital radiographic exam is more efficient than the conventional method for identification of the mineralized tissue barrier formed after pulpotomy in dogs' teeth. However, due to the benefits that the digital radiographic system can bring to Dentistry, such as less environmental impact and faster radiographic examinations, the improvement of the digital radiographic methods must be encouraged.

ACKNOWLEDGEMENTS

We wish to thank **FAPESP** for the grant to support this study (Process 01/00236-7) and **Baumer Industries** for supplying the material Gen-derm, and **Thelma Lopes Silva, Gilmar Vicente da Silva, Ovídio dos Santos Sobrinho, Tânia Mary Cestari, Erasmo Gonçalves da Silva, Luiz Carlos da Silva** and **José Messias Oliveira Filho**, for the attention and tireless help throughout the study.

RESUMO

O propósito deste estudo foi testar a hipótese de que o método radiográfico digital (Digora) em relação ao convencional permite uma melhor identificação de barreira de tecido mineralizado após pulpotomia em dentes de cães e proteção do remanescente pulpar com membrana absorvível de cortical óssea bovina desmineralizada (Grupo I) e hidróxido de cálcio (Grupo II). Foram utilizados 2 cães de acordo com as normas da "International Organization for Standardization" (ISO) 7405:1997 para os períodos experimentais de sete e setenta dias, um para o período de 7 dias e outro para o de 70 dias. Dez dentes de cada animal foram submetidos à pulpotomia, sendo 7 para o Grupo I e 3 para o Grupo II, totalizando 16 raízes tratadas para cada período. Procedimentos padronizados foram utilizados para a obtenção das imagens radiográficas. Imagem sugestiva de barreira mineralizada foi observada somente em raízes tratadas com hidróxido de cálcio, entretanto não foi observada unanimidade entre os observadores. Comparando os métodos digital e convencional imagens de barreira mineralizada foi observada em quatro e cinco raízes, respectivamente, mas apenas uma raiz pertencia ao período de 70 dias, quando a barreira dentinária era esperada. Os resultados obtidos permitem concluir que a hipótese inicial não foi confirmada.

UNITERMOS

Radiografia digital; diagnóstico por imagem; radiografia dentária; interpretação radiográfica; pulpotomia; barreira mineralizada

Table 1 - Radiographic indication suggestive of mineralized tissue formation during the 7-day period

Teeth		Observers							
	Materials	1		2		3		4	
		D ¹	C ²	D	C	D	C	D	C
1° MID mesial	HC ³								
1° MID distal	HC								
1° MIE mesial	HC								
1° MIE distal	HC								
2° PMID	MA ⁴								
2° PMIE	MA								
3° PMID	MA								
3° PMIE	MA								
CSD	MA								
CSE	HC								
3° ISD	MA								
3° ISE	MA								

¹ Digital (Digora) method, ² Conventional method, ³ Calcium hydroxide, ⁴ Absorbable membrane.

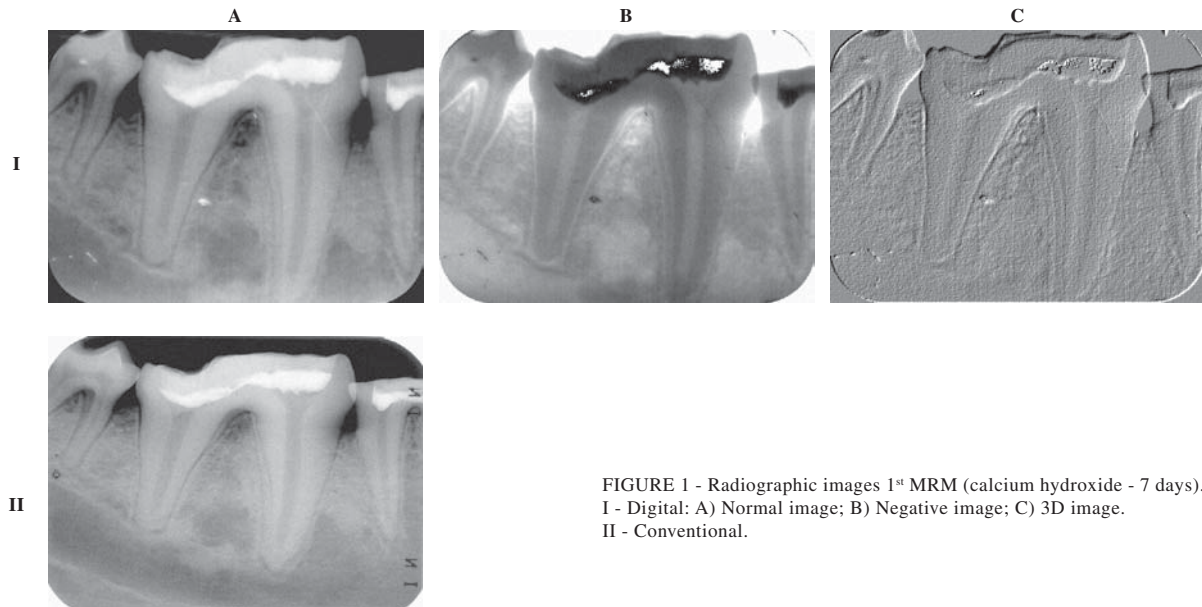


FIGURE 1 - Radiographic images 1st MRM (calcium hydroxide - 7 days).
I - Digital: A) Normal image; B) Negative image; C) 3D image.
II - Conventional.



FIGURE 2 - Radiographic images 1st MLM (calcium hydroxide - 7 days).
I - Digital: A) Normal image; B) Negative image; C) 3D image.
II - Conventional.

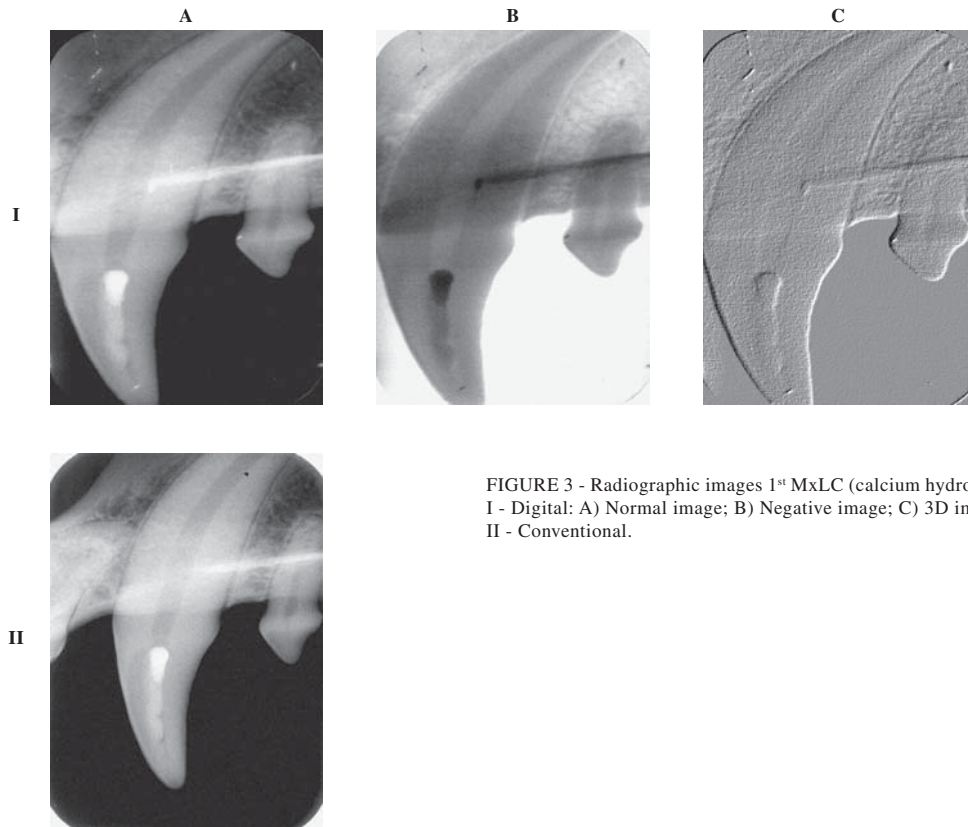


FIGURE 3 - Radiographic images 1st MxLC (calcium hydroxide - 7 days).
 I - Digital: A) Normal image; B) Negative image; C) 3D image.
 II - Conventional.

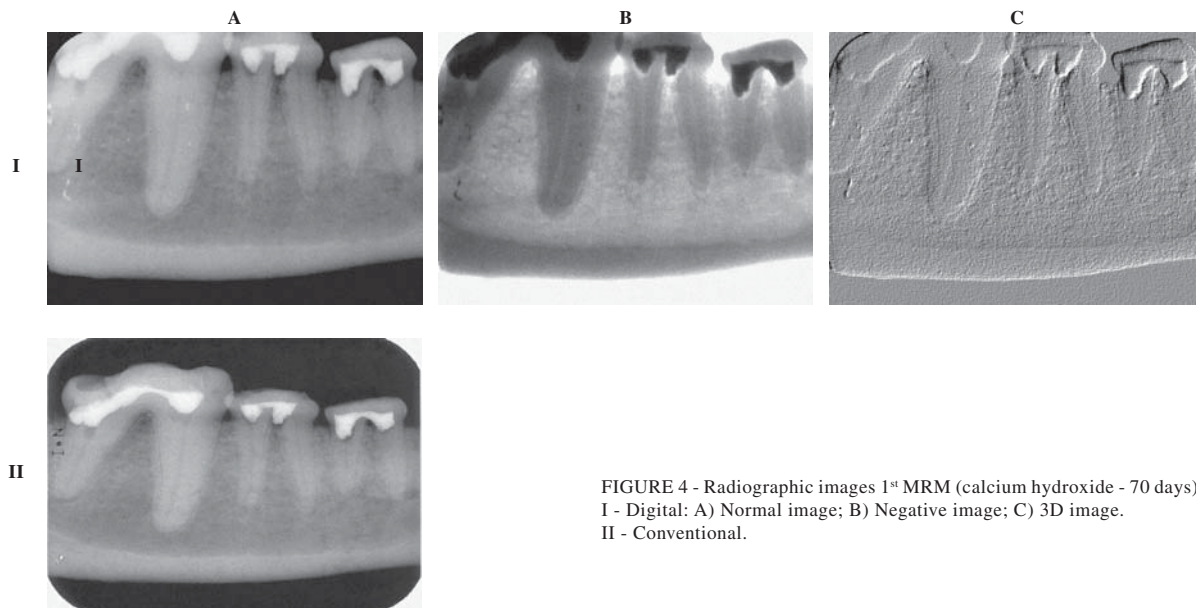


FIGURE 4 - Radiographic images 1st MRM (calcium hydroxide - 70 days).
 I - Digital: A) Normal image; B) Negative image; C) 3D image.
 II - Conventional.

REFERENCES

1. Aragonés A, Lima JEO, Martins DR, Consolaro A, Taga EM, Granjeiro JM. Uso da hidroxiapatita em pulpotomias: comportamento da polpa dental após o uso deste material como forrador. *Rev Gaúcha Odontol* 1992;40:349-50.
2. Colégio Brasileiro de Experimentação Animal (COBEA). Princípios éticos na experimentação animal. São Paulo; 1991.
3. Forner L et al. Digital radiology and image analysis for approximal caries diagnosis. *Oper Dent* 1999;24: 312-15.
4. Friedlander LT, Love RM, Chandler NP. A comparison of phosphor-plate digital images with conventional radiographs for the perceived clarity of fine endodontic files and periapical lesions. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2002;93:321-27.
5. Hildebolt CF, Couture RA, Whiting BR. Dental photostimulable phosphor radiography. *Dent Clin N Am* 2000; 44:273-97.
6. International Organization for Standardization. Preclinical evaluation of biocompatibility of medical devices used in dentistry: test methods for dental materials. ISO 7405, 1997.
7. Melius B, Jiang J, Zhu Q. Measurement of the distance between the minor foramen and the anatomic apex by digital and conventional radiography. *J Endod* 2002;28:125-6.
8. Mentés A, Gencoglu N. Canal length evaluation of curved canals by direct digital or conventional radiography. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2002;93:88-91.
9. Oliveira AE, Almeida SM, Paganini, GA, Haiter Neto, F, Bóscolo, FN. Comparative study of two digital radiographic storage phosphor systems. *Braz Dent J* 2000, 11: 111-6.
10. Pereira JC, Stanley HR. Pulp capping: influence of the exposure site on pulp healing histologic and radiographic study in dog's pulp. *J End* 1981;7:213-23.
11. Pereira JC, Bramante CM, Berbert A, Mondelli J. Effect of calcium hydroxide in powder or in paste form on pulp-capping procedures: histopathologic and radiographic analysis in dog's pulp. *Oral Surg* 1980;50:176-86.
12. Radan E, Price C. Evaluation of digital and geometric unsharpness in dental radiographs using an endodontic file model. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2002;93:208-14.
13. Silva MJA, Tavano O, Guimarães SAC, Gomes MF. Bone radiographic study associated to a castor beans polyurethane resin in surgical defects in rabbits: radiopacities quantitative analysis. *Rev Fac Odontol Bauru* 1997;5:69-77.
14. Syriopoulos K, Sanderink GC, Velders XL, van der Stelt PF. Radiography detection of approximal caries: a comparison of dental films and digital imaging systems. *Dentomaxillofac Radiol* 2000; 29:312-8.
15. Vale IS, Bramante CM. Assess lengths of endodontic files from Digora digital system and three periapical radiographic images films. *Rev Fac Odontol Bauru* 2002;10:29-33.

José Mauro Granjeiro
Al. Dr. Octávio Pinheiro Brisolla, 9-75
Laboratório de Bioquímica
Bauru-SP - CEP 17012-901 - Tel: (14) 2358246
jomagra@usp.br

Recebido: 18/07/03
Aprovado: 21/10/03