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ORIGINAL RESEARCH

Evaluation of density obturation in principal root canal with conventional X-ray scanner X-ray, radiovisiography, and cone-beam computed tomography

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ABSTRACT

Root canal obturation needs to preserve optimal clinical conditions for achieving success in patients. The aim of the present study was to evaluate endodontic obturation performed by the lateral condensation technique with manual and rotary instruments. Thirty extracted incisors were divided into two groups according to instrumentation technique: group 1-RCSMA57 + Sealapex® and group 2-spreader iRace #30 + Sealapex®. All samples were decoronated and standardized at 10 mm, intraradicular instrumentation were performed with Gates-Glidden #3, and the protocols of irrigation that were employed were 5.25% NaOCl + 17% EDTA during instrumentation. Finally, the groups were obturated with the lateral condensation technique. The samples were observed with conventional X-ray, scanner X-ray, radiovisiography, and Cone Beam computed tomography techniques. For evaluation, a scale of canal obturation density (0 = suitable, 1 = acceptable, 2 = fair, and 3 = inadequate) was employed by blinded evaluator. A value of canal obturation density was assigned in each sample. A statistical analysis by the χ^2 of Pearson with a significance level of 0.05% was employed. All groups showed different values according to the instrumentation technique employed. The rotary instrument gave better results than manual instruments according to the values expressed (p = 0.004). The both instruments can be used in the obturation lateral technique; however, the rotary instrument provides better conditions for this technique.

Keywords: Root canal obturation, X-ray, scanner X-ray, radiovisiography, Cone Beam computed tomography.

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Evaluación de la densidad de obturación en conducto radicular principal con técnicas de rayos X, escáner, radiovisiógrafo y tomografía Cone Beam

RESUMEN

La obturación del conducto radicular necesita preservar una condición clínica óptima para lograr éxito en pacientes. El objetivo del presente estudio fue evaluar la obturación endodóntica desarrollada por técnica de condensación lateral con instrumentos rotatorio y manual. Treinta incisivos extraídos fueron divididos en dos grupos de acuerdo con la técnica de instrumentación: grupo 1-RCSMA57 + Sealapex® y grupo 2-spreader iRace #30 + Sealapex®. Todas las muestras fueron de coronadas y estandarizadas a 10 mm, la instrumentación intrarradicular se realizó con Gates Glidden #3 y el protocolo de irrigación fue NaOCl 5.25% + ácido etilendiaminotetraacético (EDTA) 17% durante la instrumentación. Finalmente, los grupos fueron obturados con técnica de condensación lateral. Las muestras fueron observadas con las técnicas de rayos X, escáner, radiovisiógrafo y tomografía Cone Beam. Para la evaluación, se utilizó una escala de la densidad de obturación del conducto (0 = adecuada, 1 = aceptable, 2 = justa, 3 = inadecuada) empleada por un evaluador cegado. Un valor de la densidad de obturación del conducto fue asignado a cada muestra. El análisis estadístico empleado fue χ^2 de Pearson con un nivel de significancia de 0.05%. Todos los grupos mostraron distintos valores de acuerdo con la técnica de instrumentación empleada. El instrumento rotatorio dio mejores resultados que el instrumento manual de acuerdo con los valores expresados (p = 0.004). Ambos instrumentos pueden ser utilizados en la técnica de obturación lateral; sin embargo, el instrumento rotatorio proporciona mejores condiciones para esta técnica.

Palabras clave: Obturación del conducto radicular, rayos X, escáner, radiovisiógrafo, tomografía Cone Beam.

INTRODUCTION

In the root canal system exists variability in radicular morphology, physiology, and pathology. The pulp and periapical condition can affect the obturation in endodontic treatment. It requires good disinfection with an irrigant solution that provides flush-out debris, dissolves tissue in inaccessible morphologic spaces, eliminates bacteria, and disrupts the biofilm to avoid failure in the final obturation. The objective in endodontic obturation is to not allow fluid filtration through obtaining complete obturation and maintaining disinfected the root canal system.[1] Recently, the term monoblock has been employed by refereed quality in sealing during the obturation technique. According to the clinical goal, this term includes different interfaces between materials and tooth surfaces inside the obturated root canal.[2] Traditionally in endodontic clinical practice, the monoblock (interaction among sealer, gutta-percha, and dentine surfaces) is obtained by obturation with lateral and vertical techniques.[2,3]

The lateral condensation technique is the most frequently used. This technique does not require technology and it is possible to do with manual instruments.[4] However, one of the disadvantages of this technique is that gutta-percha cones do not adapt properly to canal walls, particularly in the presence of isthmus, C-shaped morphology, curved canals, a resorptive defect, accessory canals, and other morphological variations.[5,6] Advances in innovative technologies have been developed in vertical obturation instruments and techniques.[7,8] These advances include thermoplasticized techniques, with warm vertical condensation and core-carrier obturation.[9] These obturation methods use heat to plasticize the gutta-percha for a higher degree of homogeneity and better canal adaptation. Core-carrier obturation has been reported as the second most frequently utilized obturation method among general dentists.[5,10]

Independent of the technique and the materials employed in endodontic obturation, it is necessary to assess this procedure by clinical and radiographic approaches and to evaluate the absence or presence of clinical and radiographic symptoms.[11] Recently, different systems have been employed to evaluate the obturation, principally cone-beam computed tomography and others that include radiovisiography and scanner X-ray.[12] Finally, when the endodontic treatment is developed with technological tools (CBCT, micro-CT, and digital X-ray methods), it is possible to acquire better case planning, for the safety and prognosis of patients.[13,14]

The aim of this study was to evaluate density obturation in the principal root canal with conventional X-ray scanner X-ray, radiovisiography, and cone-beam computed tomography.

MATERIAL AND METHODS

An *ex vivo*, experimental, and blinded study was conducted. A lateral obturation technique was employed. Thirty extracted incisors were divided into two groups according to instrumentation technique: group 1-RCSMA57 (Hu-Friedy, Chicago, IL, USA) + Sealapex® (SybronEndo, CA, USA), and group 2-iRace #30 Spreader (FKG Dentaire, La Chaux-de-Fonds, Switzerland) + Sealapex® (SybronEndo, CA, USA). For evaluation a conventional X-ray (Corix® 70 Plus-USV-WM, 70 KVp, Ciudad de México, MX), scanner X-ray (FireCR Dental Reader, Herndon, VA, USA), radiovisiography (CDR Schick®, Sirona, Bratislava, Slovak Republic), and Cone-Beam computed tomography (CBCT) (Carestream DENTAL CS-9000, Atlanta, GA, USA) techniques were employed.

Sample preparation. Thirty incisors were collected and evaluated in a stereoscopy microscope (Luxeo 4D, Labomed®) to detect and discard cracks. All samples were decoronated and standardized at 10 mm. Later, all samples were pretreated with NaOCl 5.25% (3 min), EDTA 17% (5 min), and NaOCl 5.25% (3 min).[15] Samples were instrumented with Gates-Glidden #3 (FKG Dentaire) to obtain a standardized intraradicular preparation and were stored in distilled water. Samples were randomly divided into two groups with 15 in each: group 1-RCSMA57 + Sealapex®, and group 2-spreader iRace #30 + Sealapex®. Positive (Filtek™Z350) and negative (without obturation) controls were employed.

Table 1: Obturation density evaluation by conventional X-ray (CX-ray).

	n (%)			
Sample	0 (suitable)	1 (acceptable)	2 (fair)	3 (poor)
(+) control	0 (0)	0 (0)	0 (0)	3 (100)
(-) control	3 (100)	0 (0)	0 (0)	0 (0)
G1 CX-ray, Sealapex-RCSMA57	6 (40)	0 (0)	9 (60)	0 (0)
G2 CX-ray, Sealapex-iRace #30	6 (40)	9 (60)	0 (0)	0 (0)

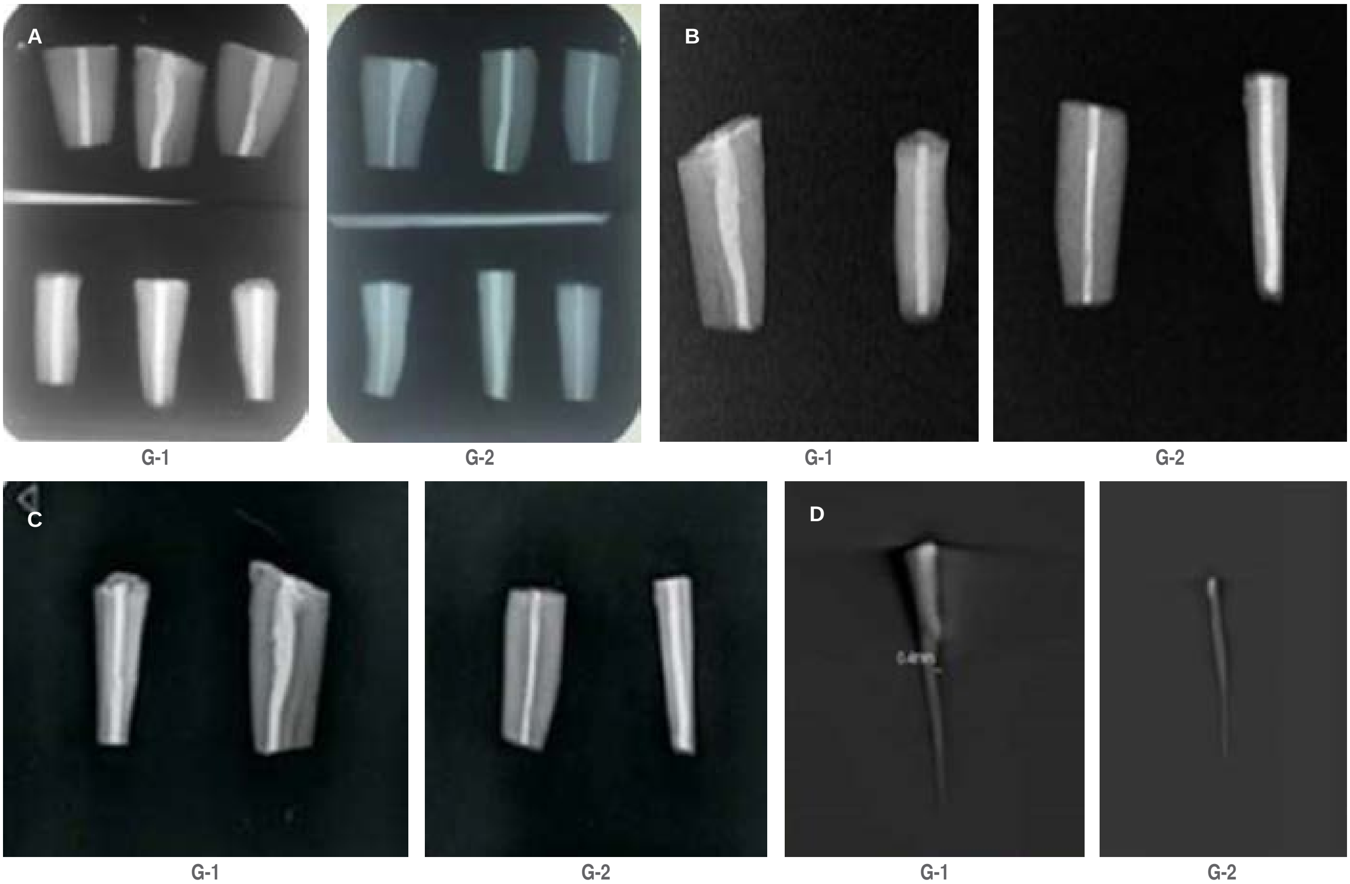

Figure 1: A) Images obtained by CX-ray. A representative image in mesiodistal and vestibule-palatal orientation by conventional radiography. G-1 (MA57) and G-2 (iRace) represent instruments employed in the lateral technique. A spaces inside obturation in G-1 is presented. G-2 reveals better obturation density. **B)** Images by SCX-ray. In the scanner, G-1 (MA57) and G-2 (iRace) images were obtained and evaluated for measurement obturation density by the lateral technique. In G-1, spaces inside of root canal were shown. In G-2, a better adaptation of the material is presented. **C)** Images by RGV. In the radiovisiography (RVG) image of G-1 (MA57) and G-2 (iRace) obtained show in mesial-distal and vestibule-palatal planes. **D)** Image by CBCT. In these images obtained by Cone Beam computed tomography (CBCT) in three planes shows gutta-percha material inside of the root canal. In G-1 (MA57) a measurement of the space between the obturation material and the walls of the dentine was 0.4 mm. In G-2 (iRace 30), measurement was not possible.

Manual obturation. After instrumentation, the samples were obturated with Sealapex®, gutta-percha principal point #30 (Coltene Hygenic), accessories points FF (Coltene Hygenic), RCSMA57 (Hu-Friedy) root canal spreader, and the lateral technique. Finally, samples were stored in distilled water.

Rotatory obturation. Samples included in the rotary group employed Sealapex® sealer, were obturated with gutta-percha principal point #30 (Coltene Hygenic), accessories points FF (Coltene Hygenic), rotary spreader iRace #30 (FKG Dentaire) at 600 rpm, and the lateral technique. Immediately on finishing the obturation, the samples were stored in distilled water.[4]

Conventional X-ray (CX-ray). A Corix® 70 Plus-USV-WM with 70 KVp X-ray was employed. In all samples, a dental periapical X-ray film #2 (Carestream, Kodak) with the parallelism technique and an exposure time of 0.05 s was taken. The films were processed according the manufacturer's instructions. The films were stored under moisture-free conditions until analysis.

Scanner X-ray (SCX-ray). A photostimulable phosphor (PSPP) imaging plate #2 (3 DISC) was utilized for image capture of the samples. The PSPP was processed in a FireCR Dental Reader X-ray scanner, and digital images were obtained. The images of all groups were stored in QuantorDent Imaging software.

Radiovisiography (RVG). For digital imaging, radiovisiography (RVG) and a #2 sensor (CDR

Schick®, Sirona) were employed. The images were obtained with a parallelism technique, an exposure time of 0.02 s and a Corix® 70 Plus-USV-WM X-ray with 70 KVp. The images were collected and stored on OrisWin DG Suite software.

Cone-Beam computed tomography (CBCT). The samples were mounted in plastic models for analysis. To obtain high-quality imaging in CBCT (Carestream DENTAL CS-9000), the images were captured in transversal, coronal, and sagittal planes and at a resolution of 12 mm. The images were processed in CS Imaging software and analyzed in CS 3D Imaging.

Analysis of the images. According to the criteria followed for recording information from X-rays established by Labarta *et al*.[16] the density of the root canal filling was evaluated with the following values: 0 (suitable); 1 (acceptable); 2 (fair), and 3 (inadequate). The kappa value for intra-observer agreement was 0.85. The samples were analyzed randomly by all techniques and a value was assigned for each sample. For the statistical analysis, a Pearson χ^2 test with a significance level of 0.05 was employed.

RESULTS

Analysis of the images of endodontic obturation obtained by traditional and digital methods was evaluated by obturation density. *Table 1* shows the values corresponding to evaluation by CX-ray and representative images obtained by this methodology are observed in *Figure 1A*. *Table 2* presents values of obturation density obtained by SCX-ray; the images that correspond to this methodology are observed in *Figure 1B*. For evaluation by RGV, the values and images are depicted in *Table 3 and Figure 1C*, respectively. In the evaluation by CBCT, the values are expressed in *Table 4* and the images representative of this method are to be found in *Figure 1D*. Finally, comparisons between instruments were made and the significance value was 0.004, with a statistical difference.

DISCUSSION

Lateral and vertical obturation techniques are used for clinical endodontic obturation, principally with warm and ultrasonic. In previous studies, both obturation techniques reported success of a 5-year follow-up by radiographic evaluation of 80.3%.[16]

For this study, a lateral condensation technique was employed. The principal reason for using this technique is that it is used by students, general dentists, and specialists with excellent prognoses in many countries, such as Belgium, Hong Kong, India, Iran, Jordan, Saudi Arabia, Turkey, the United Kingdome, Mexico, and the U.S. Furthermore, it represents an excellent clinical alternative independent of whether the professional has total access to the technology available in endodontics.[5] Other studies describe variables for recording information from periapical X-rays concerning root canal filling. These variables establish the length,

Table 2: Obturation density evaluation by scanner X-ray (SCX-ray).

	n (%)			
Sample	0 (suitable)	1 (acceptable)	2 (fair)	3 (poor)
(+) control	0 (0)	0 (0)	0 (0)	3 (100)
(-) control	3 (100)	0 (0)	0 (0)	0 (0)
G1 CX-ray, Sealapex-RCSMA57	0 (0)	6 (40)	9 (60)	0 (0)
G2 CX-ray, Sealapex-iRace #30	0 (0)	11 (73)	4 (27)	0 (0)

Table 3: Obturation density evaluation by radiovisiography (RVG).

	n (%)			
Sample	0 (suitable)	1 (acceptable)	2 (fair)	3 (poor)
(+) control	0 (0)	0 (0)	0 (0)	3 (100)
(-) control	3 (100)	0 (0)	0 (0)	0 (0)
G1 CX-ray, Sealapex-RCSMA57	0 (0)	11 (73)	4 (27)	0 (0)
G2 CX-ray, Sealapex-iRace #30	9 (60)	6 (40)	0 (0)	0 (0)

Table 4: Obturation density evaluation by Cone Beam computed tomography (CBCT).

	n (%)			
Sample	0 (suitable)	1 (acceptable)	2 (fair)	3 (poor)
(+) control	0 (0)	0 (0)	0 (0)	3 (100)
(-) control	3 (100)	0 (0)	0 (0)	0 (0)
G1 CX-ray, Sealapex-RCSMA57	6 (40)	0 (0)	9 (60)	0 (0)
G2 CX-ray, Sealapex-iRace #30	11 (73)	0 (0)	4 (27)	0 (0)

density, and taper of the obturation. These studies concluded that adequate endodontic obturation allows a minimal or non-existent space between the materials of the root canal walls because in the case of there being spaces and morphological variations, can be determined of failure in root filling.[17,18] Results of the present study show that the rotary instrument employed in the lateral technique provides a better seal and a lesser number of spaces along the obturation on evaluating the density value by conventional X-ray, scanner X-ray, RVG, and Cone Beam computer tomography (CBCT) methods.

The lateral condensation technique is used frequently in endodontics; this technique can be developed by manual and rotary instruments.[9] However, this technique can fail due to the presence of spaces and irregularities in the obturation. The presence of space or a slit as it is proposed by Romieu *et al*.[19] has been studied by two models. They developed two theoretical models for tracer penetration into the filled root canal. In the first model, an initially dry slit is described, where the movement of the tracer solution is mainly driven by capillary forces. In the second model, the slit is wet and the colorant migrates by diffusion. The authors concluded that these models correspond to the majority of experimental conditions published in the literature. This point supports our proposal that both instruments (manual and rotary) can contribute to the development of an adequate obturation technique and the avoidance of the possible presence of a slit.

Supported by other studies, we considered evaluating the samples by a traditional method, a CX-ray, SCX-ray, RGV, and CBCT.[12,20,21] Studies have been compared conventional X-ray with CBCT or micro-CT for evaluating endodontic obturation. These methods provide a 3D image and efficient tools for evaluating endodontic obturation. The main disadvantage found in digital methods can be, in some countries, their high cost.[22] Lo Giudice *et al.*[23] evaluated the accuracy of periapical radiography and CBCT in the endodontic evaluation and revealed that some important radiological signs acquired using CBCT are not always visible in the periapical X-ray. These authors concluded that CBCT could be used to solve diagnostic questions, essential for the proper management of endodontic and morphological problems.

Giudice-García &Torres-Navarro[24] described that variability in clinical techniques can permit the clinician to employ 3D obturation in root canals. Likewise, in the choice of the best obturation system or instruments, this has been performed according to case selection and operator experience. According to Giudice-García &Torres-Navarro, the selection of the MA57 instruments and the iRace spreader employed in the present study for the development of the lateral technique was mainly employing of the MA57 instrument, which can be used in root canals with > 45º curved-canal anatomical complications, compared with the iRace spreader, which cannot have utilized for curved roots that roots due to the risk of cyclic fatigue.[25]

CONCLUSIONS

Our results incorporate traditional and digital methodologies to obtain a general image of endodontic obturation. This allows the performance and the evaluation of the quality of the endodontic obturation. The endodontic obturation can be developed with different instruments. In this *ex-vivo* study, solely a density value was evaluated, and in later studies, it would be interesting to evaluate additional criteria.

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