

INFLUENCE OF IRRIGATION AND OBTURATION TECHNIQUES ON ARTIFICIAL LATERAL ROOT CANAL FILLING CAPACITY

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ABSTRACT

The aim of this study was to evaluate the influence of two different irrigation protocols on artificial lateral root canal filling capacity using different obturation techniques. Sixty single-root human teeth were used. Two artificial lateral canals were created in the apical third. Root canals were instrumented up to a 45 K-file to the working length. Before each file, root canals were irrigated either with 2 mL of 2.5% NaOCl or 2% chlorhexidine gel with further irrigation with saline solution and 3 mL of 17% EDTA. Specimens were randomly divided into three groups according to the obturation technique: (1) lateral compaction technique; (2) Tagger hybrid technique; and (3) thermoplasticized technique using BeeFill 2 in 1. All groups used AH Plus as the root canal sealer. The specimens were decalcified and cleared in methyl salicylate. The total length of lateral canals was observed

under X30 magnification with a stereomicroscope and measured on the buccal and lingual root surfaces using Leica IM50 software. The data were submitted to ANOVA and Tukey test ($p < 0.05$). Among the obturation techniques, BeeFill 2 in 1 showed deeper penetration into all lateral canals than the lateral compaction or Tagger hybrid techniques ($p < 0.05$). The lateral compaction group showed the worst results ($p < 0.05$). Irrigants did not affect the outcome; there was no difference between NaOCl and chlorhexidine when the same obturation technique was used ($p > 0.05$). Regardless of the irrigant used during endodontic procedures, the thermoplasticized techniques showed higher penetration behavior for filling artificial lateral canals than the lateral compaction technique.

Key words: Endodontics, therapeutic irrigations, root canal obturation, sodium hypochlorite, chlorhexidine.

INFLUÊNCIA DOS IRRIGANTES E DAS TÉCNICAS OBTURADORAS NA CAPACIDADE DE PREENCHIMENTO DE CANAIS LATERAIS ARTIFICIAIS

RESUMO

O objetivo do presente estudo foi avaliar a influência de dois diferentes protocolos de irrigação na capacidade de penetração de canais artificiais, utilizando diferente técnicas de obturação. Sessenta dentes humanos unirradiculares foram utilizados. Dois canais laterais artificiais foram confeccionados no terço apical do dente. Os canais foram instrumentados até uma lima K 45 no comprimento de trabalho. Antes do uso de cada lima, os canais radiculares foram irrigados com 2 mL de NaOCl 2.5% ou com Clorexidina gel 2% seguido de solução salina. Ambos os grupos receberam no final da instrumentação 3 mL de EDTA 17%. Os espécimes foram randomicamente separados em 3 subgrupos de acordo com a técnica de obturação utilizada: (1) técnica de compactação lateral; (2) técnica híbrida de Tagger; e (3) técnica termoplástica utilizando o BeeFill 2 em 1. Em todos os grupos o cimento utilizado foi o AH Plus. Depois, os elementos foram diafanizados utilizando metil salicilato. As extensões de pe-

netração dos cimentos nos canais laterais foram realizadas utilizando estereomicroscópio (X30). Os dados de cada grupo foram analisados utilizando ANOVA e o teste de Tukey ($p < 0.05$). Dentre as técnicas de obturação, a técnica termoplástica utilizando o BeeFill 2 em 1 mostrou a maior penetração em canais laterais ($p < 0.05$). A técnica de compactação lateral apresentou os piores resultados dentes os grupos testados ($p < 0.05$). Os irrigantes não afetaram a penetração dos canais laterais; não foram observados diferenças entre NaOCl e clorexidina, quando a mesma técnica de obturação foi utilizada ($p > 0.05$). Pode-se concluir que independente da substância química auxiliar utilizada, as técnicas termoplásticas de obturação demonstraram maior penetração de canais laterais do que a técnica de compactação lateral.

Palavras-Chave: Endodontia, irrigação, obturação do canais, hipoclorito de sódio, clorexidina.

INTRODUCTION

It has been demonstrated that the quality of root canal obturation is important to the successful outcome of endodontic therapy^{1,2}. The anatomy of the root canal system is composed of various irregular-

ities, creating challenges for a proper seal during obturation³. Root canal ramifications, such as lateral, secondary and accessory canals can establish connection between the main root canal and periodontal ligament, as well as the apical foramen⁴.

Several authors⁵⁻⁷ have reported that localized periodontal problems might be associated with necrotic and infected root canal ramifications, highlighting the importance of the capacity of the root canal sealers to flow into these irregularities.

Many techniques and materials have been used to fill anatomically complex root canal spaces, such as isthmuses and lateral canals. Gutta-percha is the most widely used and accepted root canal filling material. It seems to be the least toxic, least tissue-irritating, and least allergenic filling material available⁸. A variety of thermoplasticized gutta-percha techniques have been introduced recently and a number of investigations have evaluated the apical seal obtained by using them⁹⁻¹¹.

To achieve the best adaptation of filling material, it is necessary to clean the dentin wall of smear layer and debris. Root canal irrigants are used during chemomechanical procedures not only as antimicrobial agents but also to lubricate the dentinal walls, flush out debris and dissolve organic and inorganic components of the smear layer to clean dentine surface^{12,13}. However, little information is available regarding the effect of different irrigants associated to different obturation techniques on lateral canal fillings. Therefore, the goal of this study was to evaluate the influence of two different irrigation protocols on artificial lateral root canal filling capacity using different obturation techniques. The null hypothesis was that there is no influence of 2.5% sodium hypochlorite or 2% chlorhexidine gel on artificial root canal filling capacity.

MATERIALS AND METHODS

Sixty recently extracted human maxillary anterior teeth were used for this study. The crowns of the teeth were removed using a low-speed diamond disc under running water and a standard length of 15 mm was achieved for every root. The coronal and middle thirds of the root canals were shaped with size 3 and 2 Gates-Glidden burs (Dentsply Maillefer, Ballaigues, Switzerland). The working length was established by subtracting 1 mm from the measurement determined by placing a size 10 K-file (Dentsply Maillefer) into the root canal until the tip could be seen at the foramen. The apical third was prepared up to a size 45 K-file. Two artificial lateral canals were prepared in the apical third, perpendicular to the longitudinal axis of the teeth, using 0.15 mm cylindrical drills, which created the perforations. Before each file, root canals were

filled with 2 mL of either 2.5% NaOCl or 2% chlorhexidine gel; after each file, root canals were irrigated with saline solution. Then 3 mL of 17% EDTA were used for 3 min to remove the smear layer. Finally the root canals received irrigation with 3 mL of saline solution. The root canals were dried with paper points. The 60 teeth were randomly divided into six equal groups of 10. AH Plus (Dentsply) was used as the root canal sealer in all groups. The sealer was mixed according to the manufacturer's instructions and applied with a size 40 spiral Lentulo (Dentsply Maillefer), and the root canals were obturated according to the following techniques.

Group 1 (Lateral Compaction Technique): A medium gutta-percha cone (Sure-Endo, Sure Products, Seoul, Korea) was standardized with a #45 point and fitted as a master cone. Lateral compaction was performed using a #30 finger spreader (Dentsply Maillefer) and fine accessory gutta-percha cones. The excess gutta-percha was removed with a heated ball burnisher.

Group 2 (Tagger Hybrid Technique): This procedure was similar to that of Group 1. The difference was that after lateral compaction, the mass of gutta-percha was thermomechanically compacted in the coronal and middle thirds of the root canal using a #45 gutta-condensor (Dentsply Maillefer) rotated at 10.000 rpm in a slow-speed handpiece. Finally, the gutta-percha was compacted vertically using heat-carrier pluggers.

Group 3 (Thermoplasticized technique using BeeFill 2 in 1): A medium gutta-percha cone (Dentsply) was standardized with a #45 point and was fitted as a master cone. The BeeFill heat source (VDW, Munich, Germany) was activated and a small preheated plugger was inserted into the root canal to perform the down-pack. Vertical compaction was performed using heat-carrier pluggers. The middle and coronal thirds of the root canal were backfilled using BeeFill 2 in 1 device. After filling, all groups of teeth were maintained for 48 h at high humidity and 37°C to allow the sealers to set. The teeth were decalcified in 5% hydrochloric acid for 72 h and cleared in methyl salicylate¹⁴. The total length of lateral canals was observed under X30 magnification with a stereomicroscope (Leica MZ 75, Leica, Wetzlar, Germany) and measured on the buccal and lingual root surfaces using Leica IM50 software. These measurements were converted to percentages. The results were recorded, and a multiple-comparison analysis of variance test followed by a Tukey *post hoc* test were used to compare filling material flow into lateral canals ($p < 0.05$).

RESULTS

Mean values (mm) of gutta-percha penetration into lateral canals are presented in Table 1. Among the obturation techniques, the thermoplasticized technique using BeeFill 2 in 1 showed deeper penetration into all lateral canals than the lateral compaction or Tagger hybrid techniques ($p < 0.05$). The lateral compaction technique showed the worst means among the tested groups ($p < 0.05$). Fig. 1 shows representative samples of all groups. The root canal irrigants did not affect the outcome; there was no statistical difference between NaOCl and chlorhexidine when the same obturation technique was used ($p > 0.05$).

DISCUSSION

Post-treatment apical periodontitis is caused by either persistent or secondary intraradicular infection¹⁵. Persistent infections are caused by microor-

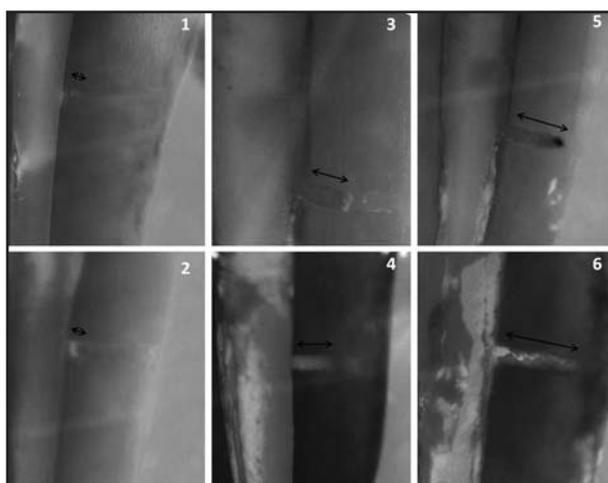


Fig. 1: Representative sample of lateral canal penetration. (a) Lateral Compaction + NaOCl; (b) Lateral Compaction + Chlorhexidine; (c) Tagger Hybrid Technique + NaOCl; (d) Tagger Hybrid Technique + Chlorhexidine; (e) BeeFill 2 in 1 + NaOCl; and (f) BeeFill 2 in 1 + Chlorhexidine.

ganisms that persisted after intracanal procedures of disinfections, especially where instruments did not reach secondary canals and dentinal tubules, and managed to survive in the filled root canal. Secondary infections, in turn, are usually caused by microorganisms introduced in the canal via bleach in asepsis during treatment or via coronal leakage in filled root canals exposed to the oral cavity¹⁶.

Ramifications in the main canal, such as lateral canals, have great clinical importance in endodontic therapy, mainly when associated with lateral lesions¹⁶. Persistent intraradicular infection caused by bacteria located within dentinal tubules can be responsible for the reappearance of apical periodontitis¹⁷. This highlights the importance of achieving proper disinfection of the root canal system for a predictable long-term treatment outcome. Bacteria causing persistent infections are usually located in areas unaffected by instruments and antimicrobial substances, including lateral canals, apical ramifications, and isthmuses¹⁸. In this study, to reproduce the conditions observed in clinical practice, simulated lateral canals were created having a diameter of approximately 0.15 mm, which matches the size of lateral canals reported in previous studies^{4,17,18}.

One of the desirable properties of irrigants is smear layer removal. Many authors have demonstrated that canal surfaces without a smear layer permit penetration of filling materials into patent dentinal tubules, increasing the contact surface and improving mechanical retention¹⁹. In this study, the teeth irrigated with 5.25% NaOCl or 2% chlorhexidine gel combined with 17% EDTA showed similar results after obturation. Previous studies demonstrated that both irrigants are highly efficient in smear layer removal^{20,21}, and this may have influenced the results.

The thermoplasticized techniques used in this study filled more lateral canals than the lateral compaction technique. This confirms the observations of Buchanan²², who states that the continuous wave of condensation can fill lateral and accessory canals with thermoplasticized gutta-percha and sealers. The literature has also reported that the warm gutta-percha technique promotes better filling quality and results in virtually no gaps, very low amounts of sealer on the root surface, and greater adaptation to dentinal walls, unlike the lateral condensation technique²³⁻²⁵. An

Table 1: Group distribution and mean penetration into lateral canals.

Obturation Techniques	Irrigant	Mean Penetration
Lateral Compaction	Sodium Hypochlorite	0.17 ± 0.07C
	Chlorhexidine	0.18 ± 0.05C
Tagger Hybrid	Sodium Hypochlorite	1.30 ± 0.48B
	Chlorhexidine	1.41 ± 0.58B
BeeFILL	Sodium Hypochlorite	3.41 ± 0.78A
	Chlorhexidine	3.62 ± 0.65A

*Different letters means statistical difference ($p < 0.05$)

interesting finding with high-temperature thermoplasticized gutta-percha obturation was its apical control. It was noted that during use of thermoplastic techniques it is necessary to take into account the accuracy and experience of the operator, since they are capable of promoting great leakage in apical region if not properly used. The null hypothesis of this study – that there is no influence of 2.5% NaOCl or 2% chlorhexidine gel on lateral canal filling capacity – was accepted. In conclusion,

regardless of the irrigant used during endodontic procedures, the thermoplasticized techniques showed better results for filling artificial lateral canals than the lateral compaction technique. Although NaOCl is widely used as an irrigant in endodontics, 2% chlorhexidine gel also has been used successfully during endodontic procedures. Based on the results obtained in this study, we can state that artificial root canal filling capacity is not affected by the irrigant selected.

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OXIDATIVE STRESS ASSESSED IN SALIVA FROM PATIENTS WITH ACUTE MYOCARDIAL INFARCTION. A PRELIMINARY STUDY

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ABSTRACT

There is evidence that acute myocardial infarction (AMI) is associated with increasing production of reactive oxygen species and tissue injury. The aim of this study was to assess the presence of oxidative stress indices in saliva 24 and 48h after AMI. **Materials and methods:** We designed a prospective study comparing salivary levels of biomarkers of oxidative stress in patients with AMI with elevation of the ST segment in electrocardiogram versus clinically healthy subjects. Oxidative stress indices including the rate of oxidation of 2',7'-dichlorodihydrofluorescein diacetate (DCFH-DA) and the activity of the antioxidant enzyme catalase (CAT) were evaluated in saliva from patients with AMI at 24 and 48 hours. At each sampling time, blood was drawn for serum markers of myocardial infarction. **Results:** This study included ten patients with acute ST-segment elevation myocardial infarction and ten clinically healthy controls. Mean age was 67.8 ± 11.1 vs. 48.7 ± 4.1 years ($p < 0.001$) and gender was 60% male vs. 50%

($p > 0.05$) for AMI vs. controls, respectively. Our results demonstrated an increase in the rate of oxidation of DCFH-DA in the myocardial infarction group as compared with controls ($p = 0.004$), which remained unchanged at 48h. There was no difference in salivary catalase activity between controls and AMI subjects at 24h or at 48h post-diagnosis ($p = 0.157$). The relationship between CAT_{48} and $DCFH-DA_{48}$ was fairly significant ($r = 0.39$; $p = 0.053$). **Conclusion:** This preliminary study showed that biomarkers of oxidative stress are detectable in saliva of patients with acute myocardial infarction. **Clinical Relevance:** Future studies using a larger population are needed to confirm these observations and to explore the possibility of using the saliva to monitor evolving diagnosis and prognosis in acute coronary syndrome.

Key Words: saliva, acute myocardial infarction, acute coronary syndrome, dichlorodihydrofluorescein diacetate, catalase, oxidative stress.

MARCADORES DE ESTRÉS OXIDATIVO EN SALIVA DE PACIENTES CON INFARTO AGUDO DE MIOCARDIO. ESTUDIO PRELIMINAR

RESUMEN

Existe evidencia que permite establecer una asociación entre la generación de especies reactivas del oxígeno y el daño tisular en el síndrome coronario agudo. El objetivo de este trabajo fue detectar en saliva de pacientes con infarto agudo de miocardio (IAM), la presencia de reactantes de estrés oxidativo a las 24 y 48 horas. **Materiales y métodos:** se efectuó un estudio prospectivo de comparación entre pacientes con IAM con supradesnivel del segmento ST en el electrocardiograma y sujetos sin patología clínica evidente. La producción de especies reactivas de oxígeno fue evaluada mediante la tasa de oxidación de la 2',7' diacetato de diclorodihydrofluoreceína (DCFH-DA) y la actividad antioxidante de la enzima catalasa (CAT) en saliva de pacientes con IAM a las 24 y 48 h de producido el síndrome coronario agudo. Simultáneamente, se determinaron en suero los biomarcadores diagnósticos de IAM. **Resultados:** se incorporaron 10 pacientes con IAM con supradesnivel del ST que fueron comparados con 10 sujetos del grupo control. La edad promedio fue

67.8 ± 11.1 vs 48.7 ± 4.1 años, respectivamente ($p < 0.001$); el 60% vs 50% fueron hombres sin diferencias entre ambos grupos ($p > 0.05$). La media de la velocidad de oxidación de la DCFH-DA fue mayor a las 24 h en los pacientes con IAM ($p = 0.004$). Estas diferencias se mantuvieron a las 48 h del infarto sin cambios significativos. No se encontraron diferencias en las medias de actividad de la enzima catalasa entre IAM y control ($p > 0.05$). Se encontró una relación entre CAT_{48} y $DCFH-DA_{48}$ ($r = 0.39$; $p = 0.053$). **Conclusiones:** En esta población se han detectado reactantes de estrés oxidativo en saliva de pacientes con IAM. **Relevancia clínica:** nuevos estudios con mayor número de casos serán necesarios para confirmar estas observaciones y evaluar la utilidad de la saliva en el diagnóstico, evolución y pronóstico del síndrome coronario agudo.

Palabras clave: saliva, infarto agudo de miocardio, síndrome coronario agudo, diacetato diclorodihydrofluoreceína, catalasa, estrés oxidativo.

INTRODUCTION

Reactive oxygen species (ROS) are oxidants/reductants and mainly regarded as hazardous species whose production in cellular and extracellular systems has to

be tightly controlled by antioxidants and radical scavenging biochemical reactions. Recently, the importance of radical species in cellular signaling and in the maintenance of homeostatic conditions has been rec-