Comparison of different methods for insertion of calcium hydroxide paste in the filling of simulated lateral canals: in vitro evaluation

Jussaro Alves **DUQUE**[1]
Matheus Alpoim Figueiredo Wychniauskas **MEDEIROS**[1]
Mariana Maciel Batista **BORGES**[1]
Rodrigo Ricci **VIVAN**[1]
Clóvis Monteiro **BRAMANTE**[1]
Marco Antonio Hungaro **DUARTE**[1]

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ABSTRACT

Objective: The objective of this study was to analyze, in micro-CT, the capacity of different methods for insertion of calcium hydroxide paste in the filling of lateral canals simulated in blocks of acrylic. **Methods:** A total of 72 acrylic blocks with lateral canals simulated in the coronal, middle and apical portions, were used and filled with calcium hydroxide paste, according to the following methods (n = 12): Group 1 - #30 K-file; Group 2 - Lentulo spiral; Group 3 - Ultrasonic agitation; Group 4 - Sonic agitation with EndoActivator; Group 5 - Syringe + Capillary Tips; Group 6 - Agitation with Easy Clean at low speed. For the groups that received agitation, the blocks were filled with the aid of a syringe and Capillary Tips. Each sample was scanned with SkyScan 1174, before and after the filling procedures, and the volume of calcium hydroxide was measured using CTAN software. The percentage of penetration of intracanal medication inside the simulated canals was calculated. Data were statistically compared ($p < 0.05$). **Results:** The agitation with EndoActivator and ultrasonic insert promoted a greater penetration of paste with significant statistical differences in relation to the #30 K-file group in the 3 levels analyzed ($p < 0.05$). Other statistical differences occurred in the comparison between the Easy Clean group and #30 K-file group in the coronal and middle thirds and in the comparison between Lentulo spiral group and #30 K-file group in the apical ($p < 0.05$). **Conclusion:** Methods which use agitation devices , such as ultrasonic insert, promoted higher filling of calcium hydroxide in simulated lateral canals.

Keywords: Pulpitis. Calcium Hydroxide. Ultrasonics.

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[1] Universidade de São Paulo, Faculdade de Odontologia de Bauru, Departamento de Dentística, Endodontia e Materiais Dentários (Bauru/SP, Brazil).

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Contact address: Mariana Maciel Batista Borges
Rua Manoel Pereira Rolla, 11-45, Vila Universitária
Bauru/SP – CEP: 17.020-190
E-mail: mmbborges@hotmail.com

Introduction

The endodontic treatment aims at prevention and healing of apical periodontitis with treatment composed by several steps. If failure in any of these steps occurs, long-term outcome may be compromised.[1,2]

The intracanal medication is one of these steps, which is indicated to reduce microbiota in infected teeth, allowing an effective antisepsis of root canals. The calcium hydroxide paste has been widely used for this purpose, due to its antimicrobial and biologic properties.[3] However, complexity areas in the root canal, such as lateral canals, imposes difficulties for adequate cleaning, shaping and disinfection procedures, because these areas are difficult to access by intracanal paste, irrigation, and endodontic instruments.[4,5] For this reason, the cleaning and insertion of intracanal medication in complexity areas are a challenge.

The ultrasonic and sonic methods have been commonly used to promote an adequate penetration of irrigant substances and sealer in anatomical complexities.[6-12] A new mechanical device for irrigant agitation, named Easy Clean (Easy Equipamentos, Belo Horizonte, MG, Brazil) was introduced and has shown good results in the cleaning andremoval of debris.[13,14] The literature about methods to analyze techniques for insertion and penetration of intracanal paste in areas of anatomical complexities is scarce.

For this reason, the purpose of this study was to compare the capacity of different methods of insertion of calcium hydroxide paste in the filling of simulated lateral canals using acrylic blocks. The null hypothesis tested was that there is no difference among the methods.

Materials and Methods

A total of 72 acrylic blocks with simulated canals which, in turn, contained lateral canals with a corresponding diameter to file #08 in coronal, middle and apical thirds, were used. The working length of the main canal was determined by the introduction of #10 K-file until the end of the block. After that, the canal was prepared using reciprocating instrument R 25.08 (Reciproc, VDW, Germany), with crown-down technique. Irrigation was performed with 30-G needle (NaviTip, UltraDent, Brazil), using 3 ml of distilled water after each filling. Thereafter, supplementary instrumentation was performed with rotary instruments size 40.04 (Mtwo, VDW, Germany). After that, the blocks were irrigated with 5 ml of saline solution and the samples were dried with paper cones. #8 K-file instruments were introduced into the lateral canals to certify that they were clean.

Apical Seal

In order to simulate clinical condition, the blocks were covered in plastic film, immersed in agar (gel) and packed in a plastic tube. The wrapping of the block in plastic film aimed at preventing the agar from penetrating into the canals.

Insertion of the calcium hydroxide paste

The 72 blocks were divided into 6 experimental groups (n = 12), according to the methods for insertion of the paste: Group 1: K-type file # 30; Group 2: Lentulo 25; Group 3: Ultrasonic - Irrisonic insert (Helse, Brazil); Group 4: Endoactivator 25.04; Group 5: Syringe + Capillary Tips; Group 6: Easy Clean at low speed.

The paste was made using powder calcium hydroxide and propylene glycol, with a ratio of 1:1 (g/ml). In order to standardize the amount of paste for sampling, pilot tests were carried out, showing 0.065 g of calcium hydroxide paste as an adequate amount.

For groups carried with agitation devices (Ultrasonic, Easy Clean, Lentulo and Endoactivator), the paste was taken into the canal using a syringe and Capillary Tips. In each group, the paste was agitated 3 times for 20 seconds. In all groups, the length was established 1mm below the working length.

Evaluation of specimens

The filling of lateral canals was evaluated by volumetric measurements using micro-CT images. The specimens were scanned before and after being filled with calcium hydroxide paste (SkyScan 1174v2, SkyScan, Kontich, Belgium) in order to provide the basis percentage of intracanal medication penetration for further comparison.

For the scanning of the acrylic blocks and capture of the images, the following parameters were used: voxel size of 22.86 µm, 0.1 rotation steps, and a 360° rotation, generating two-dimensional images with 1304x1024 pixels. The reconstruction was performed using two-dimensional images with NRecon software (NReconv 1.6.4.8, SkyScan, Aartselaar, Belgium). The

CTAN software (CTAN v1.11.10.0, SkyScan) was used for volume measurements. The analysis of the lateral canals was performed individually (coronal, middle and apical thirds).

Statistical analysis

The statistical program "GraphPadPrism" (La Joya, CA, USA) was used to compare the data obtained in each parameter evaluated. The results were submitted to a Shapiro-Wilks test to verify the normal distribution. As absence of normality was observed, Kruskal-Wallis and Dunn non-parametric tests were used. The significance level considered was 5%.

Results

Table 1 shows the results of the percentage of intracanal medication penetration in lateral canals with the different methods used. In the cervical and middle thirds, Endoactivator, Easy Clean and ultrasonic methods provided a significantly better penetration of paste than #30 K-file ($p < 0.05$). In apical third, EndoActivator, ultrasonic method and Lentulo spiral show better results than #30 K-file ($p < 0.05$). In the intragroup analysis, no statistical difference was observed among the thirds ($p > 0.05$). Figure 1 presents the representative micro-CT images of the lateral canals before and after the use of these insertion methods.

Table 1. Median values, minimum levels and percentages of penetration of hydroxide paste in lateral canals (coronal, middle and apical thirds).

	Coronal	Middle	Apical
#30 K-FILE	17,65[a] (0–53,47)	33,62[a] (0,18–62,60)	23,19[a] (0–72,21)
SYRINGE + CAPILLARY TIPS	63,17[ab] (3,39–77,54)	68,50[ab] (18,13–100)	78,11[ab] (11,38–93,81)
LENTULO	57,09[ab] (0,50–97,01)	66,88[ab] (27,76–100)	86,34[b] (6,28–100)
ENDOACTIVATOR	92,47[b] (0–100)	93,79[b] (26,11–100)	96,68[b] (45,62–100)
EASY CLEAN	82,52[b] (60,10–100)	86,35[b] (26,59–100)	66,21[ab] (41,88–100)
ULTRASONIC AGITATION	89,17[b] (31,97–100)	100[b] (17,79–100)	100[b] (16,85–100)

Different lowercase letters indicate significant differences between groups ($p < 0.05$).

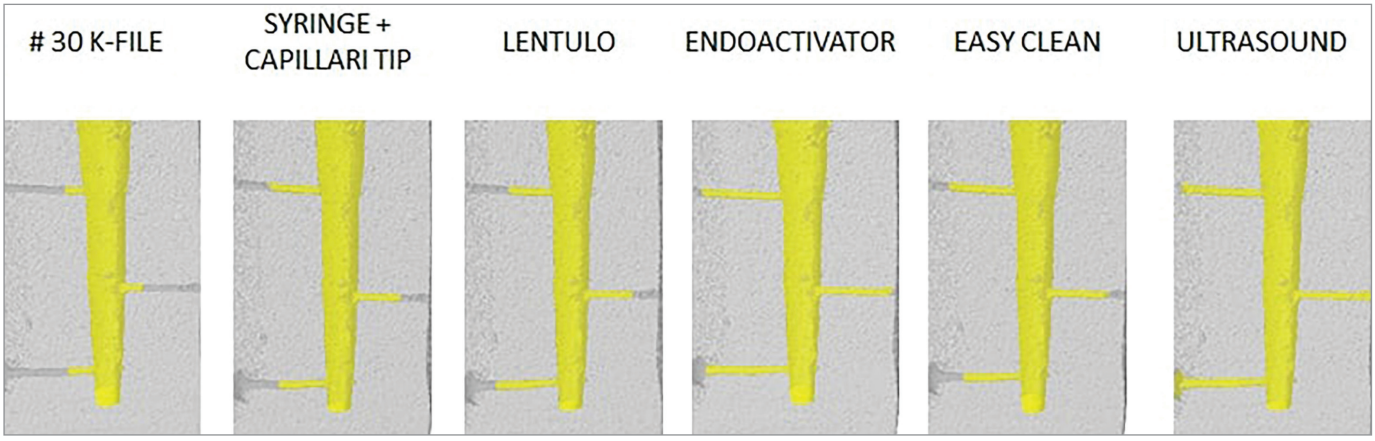

Figure 1. Representative images of the acrylic blocks and the different filling methods tested, in three thirds.

Discussion

The presence of microorganisms in anatomical complexity areas may cause the failure of endodontic treatment. Therefore, an efficient intracanal medication penetration in these areas is necessary for an adequate microbial control.[4,5] In view of this, studies about methods for insertion of endodontic paste are necessary. After the results of the present study, the null hypothesis was rejected meanwhile statistical differences occurred among the methods tested.

The literature is scarce about methods of insertion of calcium hydroxide paste, especially in complexity areas, such as lateral canals. The results show great penetration of paste in the lateral canals, what may have occurred because of the mixing of powder with propylene glycol vehicle. This is a viscous vehicle that presents low surface tension, favoring the penetration in areas of anatomical complexity.[8,15]

In addition, it was observed that the use of agitation devices favored a higher capacity of filling lateral canals. The use of #30 K-file promoted the lower percentage of penetration of paste in all thirds. In another study,[15] the ultrasonic method favored a greater penetration of calcium hydroxide paste into the dentinal tubules in relation to the manual method ($p < 0.05$). In our study, the mechanical agitation with the ultrasonic device was able to push the paste into lateral canals. Furthermore, although no statistical difference was observed among ultrasonic methods and Lentulo spiral, the results showed significantly higher percentages of paste penetration for the former in relation to the latter, corroborating with the other findings.[8]

Regarding the method using syringe + needle to insert the intracanal medication, the results in literature are contradictory. The results of our study corroborate with Simcock et al,[16] where, although the syringe method had shown better results than the manual file, no statistical difference was observed. In contrast, Staehle et al[17] obtained significantly better results for insertion of medication with a syringe in relation to the file. Besides that, the authors demonstrated no difference between the insertion with syringe and Lentulo spiral, according to the present study. On the other hand, there are studies in which the insertion with a Lentulo spiral presented better results than insertion with a syringe.[1,18]

The contradiction of results may be due to methodological differences. In studies in which syringe and Lentulo spiral were similar, straight canals were used, whereas in the other studies which presented statistical differences, canals with curvature were used. The presence of the curvature could hinder the penetration of the needle in the apical third while the fact that Lentulo spiral promoted mechanical agitation of the paste could favor greater penetration. In the present study, Lentulo has shown significantly better results than the manual file.

In reference to the insertion methods with the Easy Clean and the Endoactivator system, there are no results in the literature that allow comparisons with the findings of the present study. However, the literature shows that Easy Clean, used in low rotation, produces a mechanical action of turbulence of the irrigant solution, while Endoactivator produces a sonic agitation. Probably, for these reasons, the methods obtained significantly better results than the manual file.[14]

Despite the comparisons among the results obtained and the literature findings, there are important methodological differences. Most studies in literature analyze the penetration into dentinal tubules, through radiographs or weight. However, the present study analyzes the penetration of intracanal medication into complexity areas, such as lateral canals, using computed tomographic scanner (micro-CT). The micro-CT has been extensively used in several endodontic studies[14,20,21] and it has the advantage of obtaining volumetric results of the inserted paste, avoiding external interference from the evaluator, such as in cases where radiographic analysis is used.

In the intragroup analysis, there was no statistical difference in any group regarding the percentage of penetration of intracanal medication in the coronal, middle and apical thirds. However, it can be observed that the greatest penetration was measured in the apical third. The hypothesis for this result is that the greater agitation occurs at the final portion of the instruments removing any bubbles, as it happens when using ultrasound, Endoactivator, Lentulo and Easy Clean.[14,19,22] In the case of the syringe + needle, a plunger effect could have occurred in the apical third, providing a greater penetration of medication in that region.

Conclusion

The study concluded that methods which use agitation devices, mainly ultrasonic methods, for insertion of intracanal medication and the syringe + needle showed to be a good alternative, due to their capacity of transporting the paste to lateral canals. In addition, micro-CT demonstrated to be a great resource providing reliable results.

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