Evaluation of marginal leakage of different temporary restorative materials in Endodontics

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Abstract

Aim: The aim of this study is to assess the coronal marginal leakage of three temporary restorative materials used for root canal sealing after endodontic treatment. **Materials and Methods:** A total of 88 single-rooted teeth were submitted to biomechanical preparation and filled by lateral condensation technique. After obturation process, the teeth were randomly separated into four groups, being two teeth of each group used as positive and negative control. Temporary sealing was performed as follows: GI - Clip F (VOCO); GII - Bioplic (Biodinâmica); GIII - Vitremer (3M ESPE) and GIV - Ketak N100 (3M ESPE). Next, the specimens were immersed into Indian ink for 30 and 60- days, being 10 specimens for each time interval and then submitted to diaphanization to verify the amount of coronal leakage using a measuring microscope. **Results**: Leakage mean values within the 30-day period were as follows: Vitremer (0.3 mm), Ketak N100 and Clip F (0.6 mm) and Bioplic (1.7 mm). Within the 60-day period, leakage means were 1.1 mm, 1.5 mm, 2.2 mm and 2.6 mm, respectively. **Conclusions:** None of the materials was capable of preventing marginal leakage within the 30- and 60-day period. In both time intervals, Bioplic presented the highest mean of leakage and Vitremer the lowest.

Keywords: Endodontics, marginal microleakage, temporary restoration

Introduction

The aim of endodontic treatment is to clean, disinfect and shape the root canals with the purpose of enabling easy and appropriate filling, thus restoring the function of the tooth.[1] For this purpose, removing the agents that cause irritation of the pulp and periapical tissue through biomechanical preparation is needed.[2] All these stages are particularly important, but the sum of all the stages is the key to successful endodontic treatment.[3,4]

The final stage of endodontic treatment consists in filling the root canal system completely and compactly with materials that have physical-chemical properties, which are capable of securing hermetic sealing, making marginal leakage difficult, preventing re-infection and creating a favorable biological environment in order to enable periapical tissue repair.[5-7]

In several cases, after root canal filling, the tooth is not permanently restored in the same session, jeopardizing the recently filled root canal due to exposure.[6] The same could be said about conventional endodontic therapy, where temporary restorative materials are extensive used to perform root canal sealing between sessions.[7] Therefore, the placement of a temporary restoration with adequate properties is indispensable to prevent marginal microleakage.[8,9]

Thus, the aim of the present study was to assess coronal marginal leakage of different types of temporary restorative materials used in root canals after endodontic treatment. The null hypothesis tested was that there would be no difference in the performance of the different materials.

Materials and Methods

A total of 88 single-rooted human teeth from the tooth bank were used, after previous approval from the Research Ethics Committee of the institution. The teeth were submitted to the pulp chamber access procedure using spherical diamond bur no. 3 (KG Soresen, Barueri, SP, Brazil) coupled at high-speed MS 400 (Dabi Atlante, Ribeirão Preto, SP, Brazil) and finishing was performed with a no. 2135 cylindrical diamond bur (KG Soresen) under cooling.

The biomechanical preparation was performed using the crown-down technique and the apical stop was made with

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K-type file #40 (Dentsply-Maillefer, Ballaigues, Switzerland). At each change of the instrument, the canals were irrigated with 1 ml of 2.0% sodium hypochlorite solution (Biodynâmica, Ibiporã, PR, Brazil) using a disposable syringe and NaviTip needle (Ultradent, South Jordan, USA). After complete instrumentation, 17% EDTA (Biodynâmica) was used. After, the canals were dried with absorbent paper points and filled using the lateral condensation technique with Endofill sealer (Dentsply, Petrópolis, RJ, Brazil).

Next, the teeth were randomly separated into four groups ($n = 22$) and stored in individual receptacles. Two specimens from each group were used as positive and negative control. The temporary sealing materials tested on each group were as follows:

- Group I: Clip F temporary sealing material (VOCO, Cuxhaven, Germany)
- Group II: Bioplic temporary sealing material (Biodinâmica, Ibiporã, SP, Brazil)
- Group III: Vitremer temporary sealing material (3M ESPE, Sumaré, SP, Brazil)
- Group IV: Ketak N100 temporary sealing material (3M ESPE, Sumaré, SP, Brazil).

To perform coronal sealing, 4 mm of the filling material were removed below the root canal entrance using a no. 5 Gattes-gliden bur (Dentsply-Maillefer), but leaving enough space to place the temporary sealing materials that would fill the entire pulp chamber.

After performing coronal sealing, the root surfaces were made impermeable with cyanoacrylate ester (Scotch-Bond, 3M ESPE, Sumaré, SP, Brazil) to prevent dye penetration along the root surface.

Next, the specimens were immersed in Indian ink (Acrilex, São Paulo, SP, Brazil) for 30 and 60 days, 10 specimens for each time interval. After the immersion period, the specimens were washed under running water for 1 h, dried, and the cyanoacrylate was removed from the root surfaces with the aid of a no. 20 scalpel blade.

For the diaphanization process, the roots were immersed into a receptacle containing 5% of hydrochloric acid. After decalcification, the roots were washed under running water and placed into alcohol ascendant scale (70%, 80%, 92% and 100%) for 1 h in each scale, followed by immersion into methyl salicylate for the clarification process.

The positive control group differed from the other specimens because it did not receive the temporary sealing material. On the other hand, the negative control group was completely covered with three layers of cyanoacrylate. After diaphanization, the specimens were placed on a glass slide and taken to the optical microscope ALL 03 (Alliance, Campinas, SP, Brazil) at ×12 magnification to assess the depth of coronal leakage.

The values of coronal marginal leakage were measured in millimeters from the root canal entrance up to the most longitudinal point of dye penetration. The data of all measurements were submitted to the Kruskal-Wallis statistical test, at a 5% of level significance, using the software Graphpad Prism 4.0 (GraphPad Software, La Jolla, CA, EUA).

Results

The values obtained for the coronal marginal leakage using different sealing materials may be seen in Table 1. Irrespective of the time intervals, Bioplic presented the highest mean values of leakage and Vitremer the lowest, however, with no statistically significant difference when compared to each other and to the other materials ($P > 0.05$) [Figure 1].

Discussion

In the present study, coronal marginal leakage of different types of temporary sealing materials used in root canals after endodontic treatment was assessed. The null hypothesis tested was that there would be no difference among materials. Based on the results obtained, it could be affirmed that the tested hypothesis was accepted, since there was no significant difference in the performance of the different materials.

Coronal microleakage between tooth surface and temporary restorative materials can be assessed using different methods, being the dye penetration test the most used.[7]

Table 1: Mean values (mm) and standard deviations of coronal marginal leakage

Period (Days)	Materials			
	Clip F	Bioplic	Vitremer	Ketac N100
30	0.6±0.8	1.7±1.5	0.3±0.9	0.6±1.3
60	2.2±1.4	2.6±1.4	1.1±0.8	1.5±1.4

*There was no statistically significant difference (Kruskal-Wallis test $P<0.05$) for any of the groups ($P>0.05$)

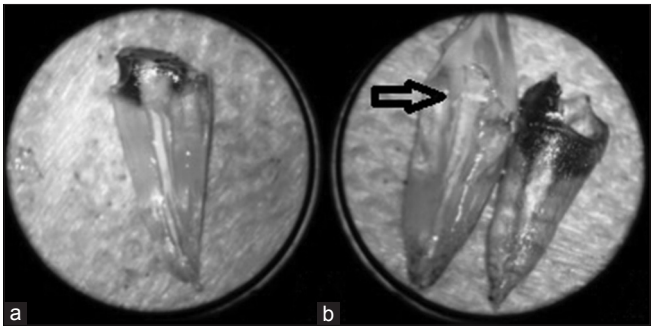

Figure 1: Linear coronal leakage measurement under optical microscope. (a) Test specimen from Vitremer group (lowest microleakage mean values). (b) Test specimen from negative control group (no dye penetration - arrow) (left) and test specimen from Bioplic group (right)

Temporary restorative materials are used in the pulp chamber access to seal the root canal system between visits in endodontic office, until a permanent restoration is performed.[9,10] Such material should effectively seal the root canal entrance from microorganism's contamination, be dimensionally stable in the presence of moist and have adequate mechanical properties. Moreover, some treatments require temporary restorations for longer periods than others. In such cases, due to the facility of removal between sessions and lower cost, temporary restorative materials are used instead of definitive materials.[9,10]

Studies demonstrated that in the absence of an adequate coronal temporary seal, contamination of root canal system could occur in less than 3 days.[10,11] Several studies have shown that these materials are incapable of preventing coronal marginal leakage, leading to root canal contamination and inducing the appearance of periapical lesions.[6,7,11]

As found in the scientific literature, the present study demonstrated that the materials tested were incapable of preventing coronal marginal microleakage in any of the samples. Although some studies[7,9] have found statistical significant differences in the performance of temporary sealing materials against coronal marginal leakage, other studies have not and are in agreement with the present study.[6,8]

The materials that presented the highest microleakage mean values, Clip F and Bioplic, have a resinous matrix-based composed of BIS-GMA, silicon dioxide, groups of dimethacrylates and organic filler particles. According to the manufacturer, polymerization shrinkage is minimal and it does not influence sealing, however, in addition to possible minimal shrinkage, they do not present any type of dentin adhesion that could avoid marginal leakage.[12]

On the other hand, the materials that presented the lowest mean values of marginal leakage, Vitremer and Ketac N100, are glass ionomer-based cements. The use of glass ionomer cements as temporary restorative materials in Endodontics has been investigated for years and studies report favorable results.[7] Glass ionomer-based cements have a chemical bonding capacity due to the adhesion between the carboxylic groups of the polyacids and the calcium ions existent in enamel, dentin and cementum.[7,13] Therefore, it was probably due to this fact that they were less prone to marginal leakage.

Moreover, Srikumar *et al*.[11] in a recent study, immersed teeth in 1% Indian ink dye after restoration with several temporary restorative materials and submitted them to bleaching and thermo cycling for 7 days. The results were demonstrated that zinc phosphate and zinc oxide eugenol-based cements were affected by the bleaching agent action and thermo cycling procedure. However, minimal leakage values were observed for hydrophilic pre-mixed temporary restorative materials under the same conditions.

The hydrophilic characteristics of both materials (pre-mixed temporary restorative material and glass ionomer-based cements) could explain the favorable results observed in the different studies.[11] Although there is no a temporary restorative material able to completely avoid contamination for a long period, these materials are capable of minimizing such contamination during and after endodontic treatment.[8]

Furthermore, none of the materials tested in the present study was capable of preventing marginal leakage within the 30 and 60 days period in any of the specimens. It was observed that coronal marginal leakage progresses over the course of time,[11,8] however, with no significant differences in the performance of materials after 30 and 60 days. This fact allow us to conclude that, irrespective of the period of time used, temporary sealing materials must not be kept in the root canals for a long period of time due to the risk of contamination.[8]

Conclusion

Despite the limitations of this *in vitro* study, it could be stated that the glass ionomer-based cements presented the lowest microleakage values. However, none of the tested materials was able to prevent microleakage for a long period of time.

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