

Qualitative Evaluation of Iodoform Diffusibility Through Dentin and Cement

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Abstract: Due to contribution of the iodoform as intracanal medication to disinfecting the root canal system, the present study sought to investigate *in vitro*, the macroscopically perceptible extra-radicular changes of a root containing iodoform as the intracanal medication to determine if the iodoform can either transpose or generate products that can transpose the dentine and cementum barriers. To this proposal, the cervical third of a palatal root of a first maxillary molar was sealed with glass ionomer and cyanoacrylate and part of the apical third of the same root was sealed with a dentin and cyanoacrylate barrier. This root containing iodoform was immersed in carbon tetrachloride and the change in color of this product was observed. The carbon tetrachloride showed changing of color about 7 days in the samples containing iodoform that become more concentrate until period of 30 days, using or not apical sealing. It can conclude that iodoform transposes or has products that transpose the dentin and cementum barriers and reaches the extra-radicular environment.

Key words: Diffusion, iodine, dental permeability, cementum, environment, immersed, maxillary molar

INTRODUCTION

One of the objectives of endodontic treatment of necrotic pulp and periapical lesion is to eliminate or at least significantly reduce infection of the root canal system and prevent reinfection. Iodoform has been used in endodontic treatment for over 100 years (Agostini, 1934). Nevertheless, some questions still remain regarding its properties and mechanism of action but it seems that Iodoform stimulates immunological response by promoting the growth of granulation tissue and thus accelerating the healing process (Ortega *et al.*, 2007; Pallotta *et al.*, 2010). Iodoform paste is used, among other indications, as filling material or as an intracanal medication (Machado *et al.*, 2009a), especially in the case of refractory lesions or lesions with large areas of periapical resorption (Machado *et al.*, 2009b).

A non-surgical method of treatment for teeth with lesions that are refractory to endodontic therapy is the intended extravasating of paste containing iodoform (Judge, 1959; Machado *et al.*, 2007) into the periapical lesion after complete chemical and surgical preparation of the root canal. This extravasating promotes closer contact between the paste and the contamination and also increases the concentration of the medication in the lesion since, there is a direct relation between the concentration and the action of the medication (Pallotta *et al.*, 2007). However in some cases, extravasation of the medicated

paste into the periapical lesion cannot be done. This inability frequently occurs clinically and can be justified due to some anatomic difficulty, due to obstruction of the root canal, due to calcifications, due to an incorrectly performed endodontic procedure and even in some cases of retreatment. In cases such as these, it is only proper to stress the importance of using medications exercising antiseptic action from a distance (Fuss *et al.*, 1996; Machado *et al.*, 2007). These medications should therefore be diffused through the dentin tubules, the accessory canals and the cementum in order to eventually reach the root surface. Hence, assessment of root permeability of the dentin and the cementum is decisive, in so far as this permeability conditions the passage of the medication throughout the endodontic system until it reaches the periodontal structures where it exercises its action. The purpose of the present study was to evaluate the possible passage of iodoform through the dentin structures by way of chemical evaluations.

MATERIALS AND METHODS

The preliminary stages needed to perform the research were carried out in a laboratory where it was found that carbon tetrachloride would be the product used in the study because it underwent a macroscopically perceptible change in the presence of iodoform powder and paste.

Evaluation of the macroscopically perceptible color change of carbon tetrachloride

Conservation and standardization of root size: In this study, freshly extracted teeth were maintained in an aqueous solution of 10% formaldehyde in order to preserve the collagen structure of the dentin tubules. After removal from the formaldehyde, the teeth were kept in distilled water for a period of no <96 h to avoid dehydration. To facilitate the mechanical-surgical preparation and standardize the specimens, the crowns of 4 first maxillary molars were removed with carborundum discs next to the amelocemental junction, producing 14 mm long palatal roots.

Preparation of canals: The canals of the four palatal roots were prepared with 1-8, 2-6 and 3-4 mm gates glidden drills to prepare the middle and cervical third and k-files, using the cervicoapical technique up to file 35 in order to standardize the ultimate diameter of the preparation:

- Two of these roots, to be used in test tubes 3 and 5 were instrumented along the entire length of the root canal. The root used to determine the amount (mass by weight) of iodoform paste to be put in contact with the carbon tetrachloride in test tube 2 and that to be inserted in test tube 4 were instrumented up to 1.5 mm short of the apical foramen with the intention of forming an as compact as possible apical dentin plug in this space
- These procedures were performed using 15 mL of 0.5% sodium hypochlorite as an irrigating solution for each root
- Upon completion of canal preparation, the canals were flooded with 5 mL of trisodium EDTA and left in this solution for 3 min under agitation and lastly irrigated with 10 mL of 0.5% sodium hypochlorite
- The canals were dried with absorbent paper cones

Distribution of the samples: Five test tubes were filled with 5.6 mL of carbon tetrachloride using a burette. Each tube contained a different carbon tetrachloride color change inducing factor explained as.

Test tube 1: Only carbon tetrachloride was placed in tube 1 to serve as the baseline comparison with the color changes effected in the other tubes.

Test tube 2: The iodoform paste was placed in direct contact with the carbon tetrachloride to enable visualization of maximum coloration of this product as

produced by the paste in the periods assessed. The standard amount (mass by weight) of iodoform paste placed in tube 2 was determined by the difference in mass using an analytical precision scale where the already instrumented palatal root of a maxillary molar was used as the baseline to arrive at this mass.

Test tube 3: The palatal root of a first maxillary molar not filled with iodoform paste was immersed in carbon tetrachloride to observe what if any color change of the product would be produced by the tooth.

Test tube 4: The palatal root of a first maxillary molar instrumented up to file 35, 1.5 mm short of the apical foramen, filled with iodoform paste and sealed at the apical and cervical levels was immersed in carbon tetrachloride to observe what if any color change of the product would be produced.

Test tube 5: The palatal root of a first maxillary molar instrumented up to file 35, up to the margin of the apical foramen, filled with iodoform paste and sealed only at the cervical level so that the iodoform paste would enter into contact with the chemical solution through the apical foramen was immersed in carbon tetrachloride to observe what if any color change of the product would be produced. Cork stoppers were immersed in 70% alcohol for 20 min and then left to dry in the air. They were then wrapped in PVC film cut into strips of 4×4 cm. The cervical part of the roots to be immersed in the carbon tetrachloride was glued to the part of the cork that would remain in contact with the product. Cyanoacrylate was selected for bonding because of its non-solubility in contact with carbon tetrachloride, according to a test performed in the 2nd stage of this study. The tubes were sealed with the cork stoppers wrapped in PVC film, in such a way that the tooth would remain immersed in the product. Tube sealing was reinforced by placing cyanoacrylate between the tube and the cork.

These 5 tubes were inverted so that the roots would remain in the position in which they lie anatomically, thus allowing contact of the product with the root without interference of air and therefore, precluding oxidation. The tubes were placed on a test tube rack, the rack was placed in a Styrofoam box and the box was closed. The reason the tubes containing the specimens were kept in a closed Styrofoam box was to replicate an environment without much light or much temperature change. Photographs were taken when the experiment was performed and after 24 h, 7, 15, 30 and 60 days (Fig. 1-5).

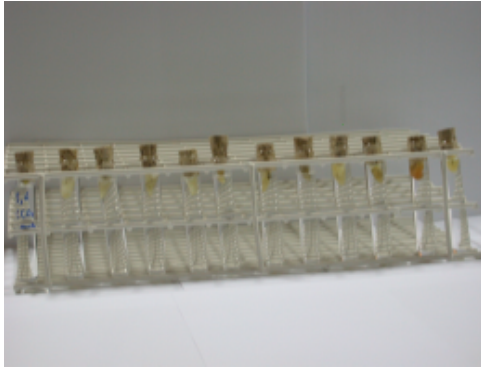


Fig. 1: Photograph of the 5 test tubes containing the factors used to evaluate and compare the change in color of the carbon tetrachloride, taken on the day the experiment was performed

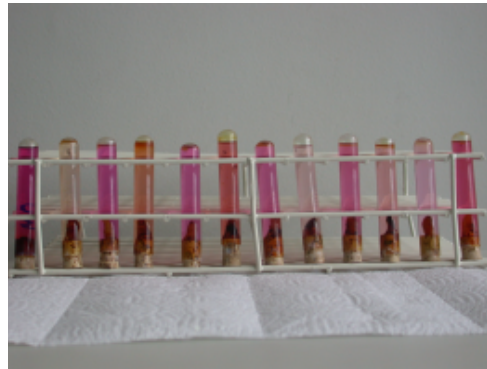


Fig. 4: Photograph of the 5 test tubes containing the factors used to evaluate and compare the change in color of the carbon tetrachloride, taken 30 days after the experiment

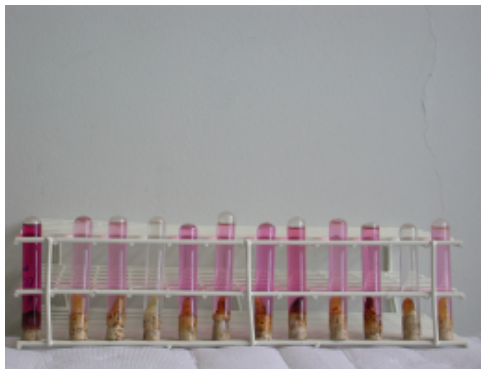


Fig. 2: Photograph of the 5 test tubes containing the factors used to evaluate and compare the change in color of the carbon tetrachloride, taken 7 days after the experiment

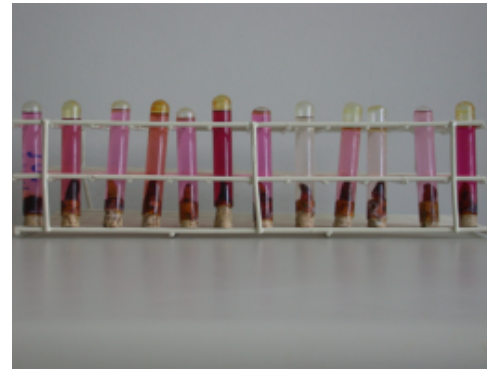


Fig. 5: Photograph of the 5 test tubes containing the factors used to evaluate and compare the change in color of the carbon tetrachloride, taken 60 days after the experiment

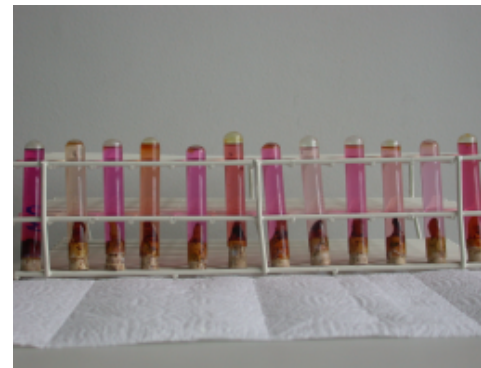


Fig. 3: Photograph of the 5 test tubes containing the factors used to evaluate and compare the change in color of the carbon tetrachloride, taken 15 days after the experiment

RESULTS AND DISCUSSION

The carbon tetrachloride showed changing of color about 7 days in the samples containing iodoform that become more concentrate until 30 days using or not apical sealing. On the day, just the sample of iodoform on direct contact showed color change. The increase of intensity over time can be seen in the Table 1. In the past, pastes containing iodoform were indicated especially for filling previously infected canals. Nowadays, iodoform paste can be used as an intracanal medication, especially in cases of refractory lesions or lesions with large areas of periapical resorption (Machado *et al.*, 2009a). Because of the great success achieved in using iodoform in endodontic treatment (Agostini, 1934; Iglesias *et al.*, 1965; Machado *et al.*, 2009b) and because of the

Table 1: Results of the macroscopic visualization of carbon tetrachloride color change according to the conditions and periods assessed

Items	On the day	7 days	15 days	30 days	60 days
Tube 01	-	-	-	-	-
Tube 02	+	+++	++++	++++	++++
Tube 03	-	-	-	-	-
Tube 04	-	++	+++	+++	+++
Tube 05	-	+++	+++	++++	++++

(-) Not detected; (+) Small color change; (++) Medium color change; (+++) Great color change; (++++) Intense color change

constant questioning in relation to its properties and mechanism of action, the study of this medication used in endodontics for over 100 years is justified. When the samples were distributed, each test tube contained a factor inducing carbon tetrachloride color change as explained before. Test tube 1 contained only carbon tetrachloride to serve as the baseline comparison with the color changes effected in the other tubes. It could be observed that the carbon tetrachloride maintained its original color, i.e., transparent during the entire period assessed. The product underwent no color change without a factor that would induce such a change.

Test tube 2 contained iodoform paste placed in direct contact with the carbon tetrachloride to enable visualization of the maximum coloration of this product produced by the paste in the periods assessed. A progressive increase in carbon tetrachloride coloration induced by the iodoform paste was observed. Test tube 3 contained the palatal root of a first maxillary molar not filled with iodoform paste. The root was immersed in carbon tetrachloride to observe what if any color change of the product would be produced by the tooth. It could be observed that the carbon tetrachloride underwent no color change and remained transparent in all the assessment periods, thus concluding that the root caused no color change of the product.

Test tube 4 contained the palatal root of a first maxillary molar instrumented up to file 35, 1.5 mm short of the apical foramen, filled with iodoform paste and sealed at the apical and cervical levels. The root was immersed in carbon tetrachloride to observe what if any color change of the product would be produced. The carbon tetrachloride coloration, macroscopically perceptible in tube 4, increased progressively directly proportional to the elapsed time.

This can be interpreted as a constant outflow of iodoform or metabolic products through the dentin tubules. However, the greatest perception of increase in carbon tetrachloride coloration was observed from day 7-15. This coloration suggests that the iodoform was diffused through the dentin tubules and the cementum or that the iodoform was drawn out by the carbon tetrachloride or even that metabolic products were drawn out with the ability to generate the same observable

result. Test tube 5 contained the palatal root of a first maxillary molar instrumented up to file 35, up to the margin of the apical foramen, filled with iodoform paste and sealed only at the cervical level so that the iodoform paste would enter into contact with the chemical solution through the apical foramen. The root was immersed in carbon tetrachloride to observe what if any color change of the product would be produced. It could be observed that there was an increase in carbon tetrachloride coloration, directly proportional to the elapsed time but with more intense coloration than that observed in tube 4 in the same assessment period.

Two new tests were conducted at a later date to obtain better certification of the methodology applied. One root was filled with only carbowax and the other had its most apical 5 mm covered with cyanoacrylate to see if there would be any interaction of the root with the vehicle or of the root with cyanoacrylate which could cause some colorimetric change in the tetrachloride. It was observed that the carbon tetrachloride remained transparent, concluding that these factors do not cause any color change of the product.

In the present study, we observed a very faint color change in the carbon tetrachloride up to the 7th day. The increase in coloration became more macroscopically perceptible from the 7-15th day but was less intense from the fifteenth to the thirtieth day. From that point on, coloration stabilized or increased very faintly.

In regard to toxicity, *in vitro* studies report a low rate of cell survival to iodoform (Wright *et al.*, 1994). However, *in vivo* examination shows that iodoform causes a greater inflammatory reaction at 15 days, as compared with calcium hydroxide (Pallotta *et al.*, 2010). Nevertheless, at the end of the 30 days, results similar to those with calcium hydroxide were observed in relation to the frequency of periapical lesion, the intensity of the inflammatory infiltrate and the repair process. Another study also showed a very similar tissue response to both calcium hydroxide and iodoform when these substances were used as intracanal medication for 30 days, as well as the presence of newly formed cementum and bone (Machado *et al.*, 2009a).

Relating these *in vivo* results with those of the present study, it was possible to observe that the greatest diffusion of iodoform or its sub-products occurred between 7 and 15 days after the experiment and that there was little change in carbon tetrachloride coloration after the 30th day, showing a reduction in the diffusion of this medication, coinciding with the repair period observed in studies *in vivo*. This therefore, suggests that the greatest diffusion of the medication between the 7th and 15th day may be responsible for inducing the lesion-healing process.

CONCLUSION

Based on the findings of this study, it is said that iodoform when placed only inside the root canal, transposes or has products that transpose the dentin and cementum barriers and reaches the extra-radicular environment.

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