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Staining Potential of Calcium Hydroxide and Monochlorophenol Following Removal of AH26 Root Canal Sealer

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Abstract

Aim: The focus of this study was to examine the staining potential of calcium hydroxide ($Ca(OH)_2$) on tooth structure following the removal of AH26 root canal sealer.

Methods and Materials: Fifty maxillary anterior teeth were prepared and obturated with AH26 and gutta percha. The sealers were then removed 24 hours later and the teeth were randomly divided into two groups. $Ca(OH)_2$ was then placed in the root canals of the first group of teeth as a medicament and camphorated monochlorophenol (CMCP) was placed in the second group of teeth after the filling material was removed. The color of the external tooth surfaces was determined before tooth preparation and two weeks after the placement of the medicaments. The Z test was used for statistical analysis.

Results: All experimental teeth showed varying degrees of coronal discoloration with the $Ca(OH)_2$ group showing more discoloration than the CMCP group ($p<0.05$).

Conclusion: Using $Ca(OH)_2$ as a medicament after removing AH26 caused progressive discoloration of the teeth, whereas using CMCP caused only slight discoloration.

Clinical Significance: To avoid staining of the treated tooth, AH26 root canal sealer must be completely removed from the dentin walls before using a medicament.

Keywords: AH26 root canal sealer, calcium hydroxide, $Ca(OH)_2$, color determination, discoloration

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Introduction

Tooth discoloration is an undesirable outcome following endodontic treatment for esthetic reasons. The common causes of endodontically treated tooth discoloration are decomposition of necrotic pulp tissue, hemorrage, endodontic medicaments, and remaining filling materials located in the pulp chamber and root canal orifices.[1,2]

Van der Burgt et al.[1] evaluated the staining characteristics of eight sealers in an *in vitro* study on extracted premolars. Their results showed the tested sealers caused significant discoloration within several weeks and more profound changes were produced by some root canal sealers.

Calcium hydroxide ($Ca(OH)_2$) has been widely used as an intracanal medication in endodontic therapy to stimulate apexification, repair perforations, treatment of root fracture, and inflammatory root resorption. It has also been used for treating infected root canals and periapical lesions. $Ca(OH)_2$ has antibacterial and tissue-dissolving properties.[3] Metzler and Montgomery[4] found intracanal $Ca(OH)_2$ left for seven days with subsequent instrumentation cleaned the canals and isthmuses.

In flare-up cases the root canal obturation generally needs to be removed from the root canal to perform retreatment procedures. However, it is not always possible to remove the root canal filling completely.[5,6] According to a study done by Gergi and Sabbagh[7] residual filling material remained in retreated teeth with only a few teeth being completely cleaned during the procedure. If the materials are not entirely removed from dentin walls and pulp chamber after obturation, subsequent staining may occur.[8]

The staining potential of $Ca(OH)_2$ treatment after removing AH26 root canal sealer was investigated in this *in vitro* study as a result of the clinical experiences of the investigators who observed coronal discoloration of retreated teeth in two cases when $Ca(OH)_2$ was used as a medicament after AH26 removal from the root canals. This raised the question of whether $Ca(OH)_2$ and AH26 root canal sealer could affect each other during retreatment procedures. The aim of this *in vitro* study was to find the answer.

Methods and Materials

Tooth Selection

Fifty freshly extracted, unrestored, caries-free human permanent anterior maxillary teeth with single canals and without any coronal discoloration were selected.

Tooth Preparation

After cleaning and polishing the external surfaces, the pulps were extirpated and the pulp chambers were instrumented through the apical access opening. A #10 stainless steel file (VDW, Antaeos, Germany) was placed into the root canal until the tip of the file reached the plane of the major foramen to estimate the true working length. The working length was determined by placing the stopper adjacent to the incisial edge of the tooth where the file tip was seen at the major foramen. The distance between the file tip and stopper was measured with a caliper. Then 0.5 mm was subtracted from the raw length measurements and the calculated value was considered to be the working length. All root canals in the present study were prepared with stainless steel hand K-files (VDW, Antaeos, Munich, Germany). The root canals were prepared at the apical foramen with K-files to a size 40 using the step back technique at the working length. A standard flare was produced using #3, #2, and #3 Gates-Glidden drills (Antaeos, Munich, Germany) using the crown-down technique. Canal irrigation was done with 6-8 ml of 2.5% sodium hypochlorite (NaOCl) for each canal. No attempt was made to remove the smear layer. Prior to obturation, the canals were dried with paper points.

Teeth were randomly then assigned to experimental and control groups. Forty teeth were used as the experimental group and ten teeth were used as the control group (five positive and five negative). The positive-controls were filled with AH26 (Dentsply. DeTrey GmbH, Konstanz, Germany) and negative-controls were only instrumented without filling with root canal sealer.

Forty root canals of the experimental group were filled with AH26 sealer using a lentulo spiral. Gutta percha cones (Diadent, Seoul, Korea) were placed into the canal using the lateral condensation technique and cut coronally using a heated hand plugger. The coronal access opening

was sealed with Cavit-G (3M-ESPE, St. Paul, MN, USA). The teeth were then stored in distilled water at 37°C for 24 hours.

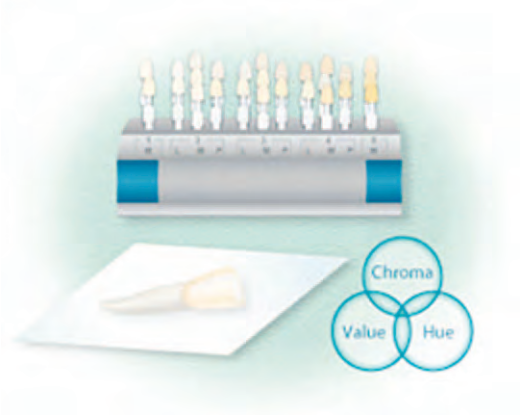
Two-thirds of the root canal filling material in each tooth in the experimental group was removed with Gates-Glidden drills in the sequence described previously. A gutta percha softener was not used. The remaining portion of the gutta percha filling was removed from the root canal using a size #35 H-type hand file and irrigating with 2.5% NaOCl. Apical cleansing was performed with a size #40 file. An attempt was made to remove all of the filling material from the root canal.

Group Assignment

The teeth were then randomly divided into two groups. In the first group the canals were filled with $Ca(OH)_2$ as a dressing material using a #35 lentulo spiral. In the second group camphorated monochlorophenol (CMCP) (prepared by the Faculty of Pharmacology, Gazi University, Ankara, Turkey) was placed in the pulp chambers of the assigned teeth as a medicament using a cotton pellet. The coronal access was sealed with Cavit (Premier Dental Products, Plymouth Meeting, PA, USA). The teeth were stored in distilled water at 37°C for two weeks.

Color Determination

Three independent evaluators who were blinded to the group of teeth they were evaluating determined the color of the teeth. During color determination the teeth were placed on a white sheet and evaluated, without visual assistance, using the Vita Toothguide 3D-Master Color Scale (American Dental Association, Chicago, IL, USA). The scale set was completed for all possible changes in color. The color of the midcervical portion of the labial tooth surface was matched to



the scale using the following color criteria:

- Value (degree of grey): 1, 2, 3, 4, 5
- Chroma (intensity or saturation): M 1, 2, 3
- Hue (quality of color; yellow, red, green, etc.): L, M, R

The labial surface of the tooth was held adjacent to the scale. One point was given for each change in value, chroma, and hue. No points were given if no change was observed in these characteristics. The scores of each tooth were totaled and the quantity of color change was determined.

The sums of the differences for three criteria (value, chroma, and hue) were calculated first. Color improvement was determined by subtracting the post-treatment score from the original score. For example, as shown in Table 1, the original value rating of a tooth was 1 and after treatment it is found to be 3. This means the change in the value rating was 2 degrees which resulted in a score of 2. Likewise the initial rating of the chroma was M1 and at the second examination after two weeks it was rated at M3. Since the change in the chroma was found to be 2 it was given a score of 2. Since there was no difference in hue it was given a score of 0. Adding the three scores the

Table 1. An example for calculating the color change.

	Original	After 2 weeks	Score
Value	1	3	2
Chroma	M1	M3	2
Hue	L	L	0
Total Score			4

final score of 4 for the change in color of the tooth in this scenario was obtained. The data from three investigators were statistically analyzed using the Z test (p=0.05). The other groups were calculated in the same manner.

Results

Negative controls showed no evidence of discoloration. Positive controls showed immediate and severe coronal discoloration. All experimental teeth showed varying degrees of coronal discoloration.

Two groups which were evaluated pre and post experimentally showed statistically different results ($p<0.05$). The $Ca(OH)_2$ group showed more discoloration than the CMCP group.

Discussion

The aim of this *in vitro* study was to compare the staining potential of $Ca(OH)_2$ and CMCP in retreatment endodontic cases.

The results of the present study showed the effect of $Ca(OH)_2$ on tooth discoloration when AH26 was used as a sealer. It is known $Ca(OH)_2$ does not cause the staining of the tooth structure. However, sealers containing silver or any other heavy metals such as AH26 will stain dentin.[4] Although the authors hypothesized $Ca(OH)_2$ has a potential of staining via interaction with AH26 the molecules having such staining potential is still unknown. Consequently, further investigations should be done.

In the present study discolorations mostly occurred at the cervical area of the teeth. This can be explained by the existence of the thin enamel layer in the cervical area which covers the greatest bulk of dentin also located in this area of the tooth. Since enamel is a translucent and rather colorless material the stained tooth structure is dentin which is visible through the thin enamel layer.[9] This finding is in agreement with Parsons et al.[2]

Although endodontic sealers are intended to fill only the root canals, sealer remnants are often left behind in the crown area. Even after mechanically removing the sealer remnants can be found in this area of the tooth. Clinicians should make an effort to remove the sealer as much as possible for if remnants are left behind they will induce discoloration.[1] The coronal discoloration might be a result of diffusion of the sealers through dentinal tubules. In this study the root canals were filled with AH26 sealer, and the sealer was placed in the pulp chambers with no effort to remove the bulk of the material.

In the present study there was a significant discoloration in the cervical area of the teeth in the $Ca(OH)_2$ group. However, the CMCP group showed little discoloration which was not very important because both the chemistry and the application of two medicaments are different. The study was limited to the investigation of the staining potential of only these two chemicals. The interaction between AH26 and these chemicals should be further investigated for more parameters to compare the effects on dental tissues.

Tooth color was evaluated with the naked eye using the Vita Toothguide 3D Master color scale to determine differences in color changes using

the three color characteristic of value, hue, and chroma according to the study done by Van der Burgt et al.[1] This method seems to be more sensitive in detecting color changes.

Conclusion

Using $Ca(OH)_2$ as a medicament after removing AH26 caused progressive discoloration of the teeth whereas using CMCP caused only slight discoloration. The results of this *in vitro* study confirms the initial hypothesis $Ca(OH)_2$ can stain the teeth when placed after removing AH26.

Clinical Significance

To avoid staining of a treated tooth, AH26 root canal sealer must be completely removed from the dentin walls before using a medicament such as CMCP or $Ca(OH)_2$.

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