Original Article

Ex Vivo Comparison of the Discoloration Potential of Two Endodontic Sealers in Human Incisors

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Abstract

Background and Aim: Tooth discoloration induced by endodontic materials is a common finding which can impair the aesthetic outcome. The aim of this study was to compare the coronal discoloration induced by Well-Root ST and AH26 root canal sealers by using the Easyshade® colorimeter.

Materials and Methods: Forty-five intact maxillary central incisors were involved in this experimental study. The prepared specimens were randomly distributed in experimental and control groups as follows: group 1 (Well-Root ST, n=15), group 2 (AH26, n=15), positive control group (amalgam, n=5), negative control group1 (gutta-percha, n=5), and negative control group 2 (distilled water, n=5). In order to evaluate the discoloration rate (ΔE), The Easyshade® spectrophotometer was used at one and six months post-obturation. Analysis of variance (ANOVA) was used to compare color changes in the groups at the mentioned time intervals.

Results: The difference between the experimental groups (Well-Root ST and AH26) and the negative control groups was not statistically significant (P=0.99) at one and six months after obturation. However, the difference between the experimental groups and the positive control group was significant (P=0.000). The difference between the positive control group and the negative control groups was also significant (P=0.000).

Conclusion: The results of the current study indicate that both experimental sealers (Well-Root ST and AH26) have minimal discoloration effects and can be used safely in the aesthetic zone.

Key Words: Tooth Discoloration, Root Canal Filling Materials, Esthetics, Dental

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Introduction

The aesthetic appearance of endodontically treated teeth is important for clinicians and significantly affects the patients' quality of life, especially in the anterior region of the mouth [1]. A major etiological factor for coronal discoloration of endodontically treated teeth is the remnants of root canal sealers in the pulp chamber [2,3]. Certain components such as phenolic compounds or heavy metal additives may be the cause of discoloration [4]. Bleaching of such discolored teeth is more difficult and less effective compared to the teeth discolored due to other causes [5]. Despite the ideal properties of endodontic sealers such as creating an adequate seal and biological compatibility, the sealers' discoloration potential could have a significant role in the choice of an appropriate root canal sealer in the clinic [6]. Well-Root ST (Vericom, Seoul, South Korea) is a premixed, ready-to-use, injectable bioactive

calcium silicate-based paste for root canal obturation. This sealer requires the presence of moisture to set [7].

In an in-vitro study by Demiral et al [8], it was concluded that the discoloration effect of Well-Root ST was comparable to that of MTA (mineral trioxide aggregate)-Fillapex (Angelus, Londrina, Parana, Brazil) and Dia-Proseal (Diadent, Seoul, South Korea) root canal sealers, and this effect was more prominent than that in the control group. The biggest disadvantage of using calcium silicate-based materials is their discoloring effect on coronal dentin [9].

AH26 root canal sealer (Dentsply Maillefer, Tulsa, OK, USA) is a resin-based, non-acrylic, eugenol-free sealer and filling material suitable for cold and warm obturation techniques. The silver ion in the old formulation was responsible for the discoloration potential of this material, which was omitted from the new formulation [10].

The American Dental Association (ADA) recommended the use of the CIELAB color differential system to determine the color changes of an object [9]. This system numerically expresses the color difference between two objects. The VITA Easyshade® (VITA Easyshade® Compact; VITA Zahnfabrik, Bad Säckingen, Germany) is a colorimeter instrument using spectrophotometric technology which its accurate and predictable results have been proven in previous studies [10].

The aim of the present study was to compare the discoloration potential of Well-Root ST and AH26 endodontic sealers in human incisors by using the VITA Easyshade® colorimeter.

Materials and Methods

Forty-five intact maxillary central incisors were included in this experimental study. Teeth with caries, restorations, developmental defect, or cracks were excluded from the study. The teeth were cleaned by using a rubber cup and pumice powder to remove stains from the coronal surface, and then, they were immersed in normal saline until the examination day.

The sample size in each experimental group (n=15) was determined by using the Minitab software program (Minitab Inc., State College, PA, USA) by considering α=0.05, β=0.2, standard deviation (SD) of ΔE (discoloration rate) =1.5, and the least significant difference of ΔE=1.6.

The two-third apical part of the roots was removed by using a diamond bur mounted on a high-speed handpiece with an air-water cooling system. Next, coronal access cavities were prepared in all the teeth. Specimens with a buccal diameter (from the buccal surface to the pulp chamber) greater than 3 mm were excluded from the study (Figure 1).

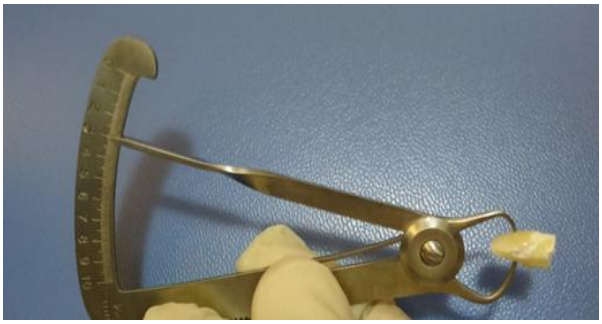

Figure 1. Gauging the buccal diameter of teeth after access cavity preparation

The XS orifice shaper (Dentsply Maillefer, Ballaigues, Switzerland) was used for root canal preparation. In order to remove the smear layer, 5.25% sodium hypochlorite (NaClO) and 17% Ethylenediaminetetraacetic acid (EDTA) were used, each for one minute, with a final rinse by distilled water. The initial color assessment was done in the mid-buccal coronal surface by the VITA Easyshade® colorimeter instrument with the aid of a stabilizing stent made of a silicone impression coping material (Speedex, Coltene, Switzerland). The prepared specimens were randomly distributed in experimental and control groups as follows: group 1 (Well-Root ST, n=15), group 2 (AH26, n=15), positive control group (amalgam, n=5), negative control group 1 (gutta-percha, n=5), and negative control group 2 (distilled water, n=5).

Each experimental specimen was dried and filled by using Well-Root ST or AH26 endodontic sealers and thermoplasticized gutta-percha (E&Q Master Set, Meta-BioMed Co., Ltd., Korea) to 1mm below the cementoenamel junction (CEJ), and a cotton swab was used to remove sealer remnants from the pulp chamber (Figure 2).

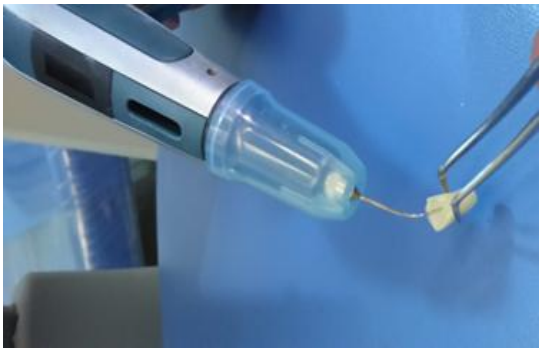

Figure 2. Thermoplasticized gutta-percha obturation of root canal space after sealer placement

Figure 3. Color evaluation by using the VITA Easyshade® spectrophotometric device

Afterwards, the coronal access cavity was sealed by the use of a resin-modified glass ionomer (conv-RMGI; Fuji II LC, GC America Inc., Alsip, IL, USA). In the positive control group, the pulp chamber was filled with amalgam (Dispersalloy; Dentsply/Caulk, Milford, DE, USA). The samples in the negative control group 1 were filled with thermoplasticized gutta-percha to 1mm below the CEJ without using a sealer and were sealed by the use of the resin-modified glass ionomer. The teeth in the negative control group 2 were only rinsed with distilled water and were sealed by using the resin-modified glass-ionomer. The samples were immersed in distilled water and were incubated at 37°C and 90% humidity. The follow-up time points were one and six months after obturation. The distilled water was refreshed every week.

Evaluation of discoloration:

The difference (ΔE) between the baseline color and the color at the follow-up sessions was calculated by CIELAB color system (VITA Easyshade® Compact, VITA Zahnfabrik, Bad Säckingen, Germany). Any change in the hue, value, or chroma of a tooth was considered as discoloration. In order to evaluate the discoloration rate in the current study, VITA Easyshade® colorimeter (VITA Easyshade® Compact; VITA Zahnfabrik, Bad Säckingen, Germany) was used (Figure 3). At the follow-up time points, photos were taken from the mid-labial surface of each tooth in a dark room with the aid of the stabilizing stent which fixed each specimen at the same distance from the VITA Easyshade® instrument tip. The data related to each sample were recorded and compared with pretreatment photos. The discoloration rate of each tooth was measured as follows [11]:

$\Delta E = [\Delta(\Delta L^2)+(\Delta a^2)+(\Delta b^2)]^5$

ΔE= Total discoloration

ΔL= Value changes

Δa=Chroma changes for red and green

Δb= Chroma changes for yellow and blue

In order to compare the discoloration rate in each group at different time points, the data were entered into SPSS software program (version 20, IBM Co., Chicago, IL, USA) and were analyzed by analysis of variance (ANOVA).

Results

The discoloration rate was measured in experimental and control groups at one-and six-month intervals (Table 1).

The difference between Well-Root ST group and negative control group1 (gutta-percha without sealer) at the first (P=0.98) and the second (P=0.99) follow-up intervals was not significant. Likewise, the difference between the discoloration rate of Well-Root ST and negative control group 2 (distilled water) was not significant at the first (P=0.892) and the second (P=0.985) follow-up sessions. The difference between AH26 group and negative control group 1 (gutta-percha without sealer) at the first (P=0.998) and the second (P=0.819) follow-up time points was not significant. Also, the difference between the discoloration rate of AH26 and negative control group 2 (distilled water) was not significant at the

Table 1. Mean ± standard deviation (SD) of the discoloration rate (ΔE) in the evaluated groups at different follow-up time points

Interval Groups \ Time	1 month EΔ	6 months EΔ
Well-Root ST	4.3±2.4	7.1±3.9
AH26	4.02±2.2	8.5±2.9
Positive control	9.71±2.4	12.49±2.2
Negative control 1	3.5±1.4	6.6±2.6
Negative control 2	3.09±1.2	6.08±0.7

first (P=0.962) and the second (P=0.627) follow-up intervals.

The difference between Well-Root ST group and the positive control group (amalgam) was significant at the first month (P=0.000) and at the sixth month after obturation (P=0.01). The difference between AH26 group and the positive control group (amalgam) at the first and sixth months after obturation was significant (P=0.000). Likewise, the difference among the positive control group and negative control group 1 (gutta-percha without sealer) at the first (P=0.001) and sixth months (P=0.04) and the negative control group2 (distilled water) at the first (P=0.000) and sixth months after obturation was significant (P=0.022).

The results indicate that both experimental groups (well-Root ST and AH26 sealers) showed minimal discoloration effects comparable to that of the negative control groups (distilled water and gutta-percha) and lower than that of the positive control group (amalgam).

The color changes in the experimental groups (Well-Root ST and AH26) at the first (P=0.99) and at the second (P=0.80) follow-up time points were not significantly different.

Discussion

In this study, the effect of two endodontic sealers (Well-Root ST and AH26) on coronal discoloration was studied at one- and six-month follow-up intervals. The results indicated that both Well-Root ST and AH26 root canal sealers had minor discoloration effects on coronal dentin comparable to that of the negative control groups. The results showed that these sealers are suitable for use in the aesthetic zone. The two-third apical part of the specimens was removed [12,13] because it had no impact on coronal discolorations. The remaining root canal space was filled by thermoplasticized gutta-percha which is one of the most common modalities for the obturation of the coronal part of root canals [14]. Two negative control groups (gutta-percha and distilled water) were considered for this study since previous studies have shown that the teeth filled with gutta-percha or distilled water show discoloration over time, and these changes may camouflage the color changes related to endodontic sealers [15]. AH26 sealer is one of the most common resin-based sealers used in endodontics with perfect sealing properties and antibacterial effects [12]. Unfortunately, the silver ion in old formulations causes moderate to severe discolorations making the sealer unfavorable for aesthetic regions. The silver ions have been removed from the new formulation of the material (silver-free AH26); this change leads to minimal color changes related to sealer remnants in the pulp chamber. Well-Root ST is a calcium silicate-based material and one of the newly proposed biocompatible root canal sealers in endodontic treatments. The main disadvantage of calcium silicate-based materials is their discoloration potential [6]. Maxillary central incisors were chosen for discoloration ratings because of their important role in aesthetics [1].

We used amalgam filling material instead of lysed blood cells [16,17] because of ease of use and cost-effectiveness. Heavy metal ion distribution in

dentinal tubules is the main cause of severe discoloration observed in the positive control group. A mild color change was observed in negative control groups because of the change in moisture and collagen cross-linking of dentin, which have also been confirmed by previous studies [18].

In this study, the excess sealer was removed from the access cavity [19], instead of completely filling the pulp chamber with sealer [20], to reach a closer simulation of the clinical application of root canal sealers.

Follow-up time points for the assessment of the discoloration potential of dental materials varies in different studies. Parsons et al [21] reported that the highest level of color change occurred during the first phase of their study (after 3 months), similar to the results reported by Shahrami et al [12]. They concluded that close follow-up intervals would yield more precise results.

On the other hand, Lenherr et al [20] stated that after 12 months, the discoloration progressed in their experimental groups. In the present study, the discoloration rate of the specimens was assessed at one- and six-month post-obturation to compare the color changes at immediate and late follow-up time points.

Recently, it has been suggested that the smear layer might be an obstacle for effective disinfection of radicular space, and its presence reduces the sealing ability of root filling materials. In addition, it has been reported that the smear layer can significantly decrease dentin permeability and can prevent the penetration of root canal sealers into dentinal tubules. This phenomenon may affect the discoloration rate [22]. Therefore, in this study, the samples were irrigated by 17% EDTA and 5.25% NaOCl to remove the smear layer [21,23].

Spectrophotometric analysis of color changes leads to 33% more reliable and 93.3% more predictable results in comparison with visual analysis and other conventional methods [24].

Conclusion

The results of the present study indicate that both experimental sealers (Well-Root ST and AH26) have minimal discoloration effects and can be used safely in the aesthetic zone.

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