International Journal of Medical and Health Research
ISSN: 2454-9142
Received: 15-02-2019; Accepted: 27-02-2019; Published: 16-03-2019
www.medicalsciencejournal.com
Volume 5; Issue 3; 2019; Page No. 213-215

A cross sectional study of tooth discoloration caused by endodontic treatment

Shahid Ali Wani[1], Ajmal Mir[2*], Atif Hussain[3]
[1] Postgraduate Student, Department of Conservative Dentistry and Endodontics, Sardar Patel Postgraduate Institute of Dental and Medical Sciences, Lucknow, Uttar Pradesh, India
[2] MDS, Department of Conservative Dentistry and Endodontics, Government Dental College, Srinagar, Jammu & Kashmir, India
[3] BDS, Maharaja Ganga Singh Dental College and Research Centre, Sriganganagar, Rajasthan, India
Corresponding Author: Ajmal Mir

Abstract
Aim: To evaluate crown and root discoloration promoted by different endodontic sealers after root canal filling.
Methods: Eighty bovine incisors were prepared and filled with: Endofill, Sealer 26, AH Plus, and MTA Fillapex. Color was recorded using a spectrophotometer before endodontic treatment (T0) and at 24 hours (T1), seven days (T2), 30 days (T3), and 90 days (T4) after treatment. Analyses were performed on the middle and cervical regions of the crown, and on the cervical third of the root, immediately below the cementoenamel junction. The color alterations (ΔE) were calculated using Commission International de I'Eclairage (CIE) L*a*b parameters, and data were analyzed by analysis of variance (ANOVA) and Tukey's test ($p<0.05$).
Results: All sealers induced color alterations. Sealer 26 resulted in the smallest changes in color (DE = 5.32). The other materials did not present statistical differences (AH Plus DE = 6.98; MTA Fillapex DE = 6.88; Endofill DE = 6.41). Of the three regions analyzed, the largest discoloration was observed at the cervical third of the root (DE=10.67). In terms of time, the largest ΔE values (DE=7.72) were observed at T4. Color changes at T1 (DE=5.88), T2 (DE=6.10), and T3 (DE=5.89) were statistically similar.
Conclusions: All endodontic sealers promoted discoloration on the tooth crown and root.

Keywords: endodontics. Root canal filling materials. Tooth crown. Tooth discoloration

Introduction
Tooth discoloration can occur due to penetration of endodontic materials into the dentinal tubules during root canal treatment [1]. Crown discoloration is well known; however, crown and root discoloration induced by root canal sealers can be different due to the arrangement of dentinal tubules in different areas of the tooth. Root discoloration is relevant if periodontal plastic procedures are needed, especially in cases of localized gingival recession or surgery, including bone resection for patients requiring aesthetic treatments. Additionally, it is also an important factor when direct or indirect veneers or full crowns are indicated. Thus, root discoloration may influence the periodontal and/or prosthetic treatment, as well as the overall aesthetic results. Several studies have demonstrated crown discoloration induced by endodontic sealers containing zinc oxide, calcium hydroxide, and resin cements [2, 6].

The materials used for root filling may also induce tooth discoloration, particularly if left in the pulp chamber and above the gingival margin. The discoloration is usually seen in the cervical third of the crown since the overlying, which is a translucent and colorless structure, is thinner in this area [7, 8]. This discoloration may be prevented by complete removal of sealer remnants, cutting the filling material below the cementoenamel junction, or through the use of sealers that do not cause tooth discoloration6.

However, root canal cements usually cause discoloration because of the presence of unreacted components or the corrosion of some components owing to moisture and/or chemical interaction with dentine [7, 9]. The color stability of endodontic sealers may also be affected by their different chemical components. The components of endodontic sealers that are related to color change of the tooth are bismuth trioxide [9], silver [10, 11], and iron oxide [12].

Many studies have investigated the discoloring potential of root canal cements [2, 4, 7, 11, 13, 15]. However, several methodological differences - especially in whether the smear layer is removed, and how color change is determined (by either vision or computer analysis of digital images) - result in difficulties when interpreting the data [1]. Therefore, this study investigated crown and root discoloration promoted by different endodontic sealers after root canal filling using spectrophotometric analysis. The study hypotheses were that there would be significant discoloration differences regarding (i) the tooth area evaluated (middle and cervical regions of the crown, and coronal third of the root); (ii) the endodontic sealer evaluated; and (iii) the time period after root canal filling.

Material and Methods
Eighty bovine incisors were extracted, cleaned using ultrasound to remove debris and extrinsic stains, and then stored in water at room temperature at the GDC (Srinagar). The specimens were randomly divided into four groups (n = 20) according to the endodontic sealer: Endofill (Dentsply, Petrópolis, Brazil), Sealer 26 (Dentsply, Petrópolis, Brazil), AH Plus (Dentsply DeTrey, Konstanz, Germany), and MTA Fillapex (Angelus, Londrina, Brazil).

Commission International de I'Eclairage (CIE) L*a*b

parameters [16] were recorded using Easyshade Spectrophotometer (VITA Zahnfabrik, Bad Säckingen, Germany) before preparation and root canal filling (baseline, T0). Color readings were always recorded on three assessment points: (i) the middle third of the crown (CM); (ii) the cervical third of the crown (2 mm above the cementoenamel junction) (CC); and (iii) the coronal third of the root, immediately below the cementoenamel junction (R). Each point was measured three times, and the final value was the mean of these readings.

Coronal opening was performed, followed by root canal treatment. The root canals were prepared using a crown-down technique and K-files; each canal was prepared to a size 90 K-file (Denstply Maillefer, Ballaigues, Switzerland), which was the master apical file using 2.5% sodium hypochlorite solution (Biodinâmica, Ibiporã, Brazil) and 17% ethylenediaminetetraacetic acid (EDTA) (Biodinâmica, Ibiporã, Brazil) as irrigant. The specimens were filled by Tagger's hybrid technique, using standardized (size 90) and nonstandardized (fine-medium size) gutta-percha cones (Denstply Maillefer, Ballaigues, Switzerland) as master and accessory cones (Denstply Maillefer, Ballaigues, Switzerland), respectively. Sections were then done 2 mm below the cementoenamel junction.

After cleaning, the pulp chamber was dried with cotton pellets, and the crown was sealed with glass ionomer cement (Shade A3, Vidrion R, S.S. White, Rio de Janeiro, Brazil). Subsequent color readings were obtained at the following time periods after completion of endodontic treatment: 24 hours (T1), seven days (T2), 30 days (T3), and 90 days (T4). For standardization purposes, the same operator carried out all measurements.

The color difference (ΔE) between baseline and subsequent readings were calculated according to the equation:

$$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)\ 2]^{½}$$

Where ΔL*, Δa* and Δb* are the differences between the parameters before (baseline) and after each period of time (ΔE1 = 24 hours and baseline; ΔE2 = 7 days and baseline, ΔE3 = 30 days and baseline and ΔE4 = 90 days and baseline). When ΔE was between 1 and 3.7, the color change was considered acceptable. Values higher than 3.7 were considered clinically relevant and highly noticeable as considered in previously literature, with the same cut-off values using spectrophotometric analysis [13, 17].

Data were analyzed using three-way analysis of variance (ANOVA) (endodontic sealer, tooth region, and time) over repeated measurements and Tukey's honest significant difference (HSD) test with a significance level of 0.05.

Results

The mean values of ΔE with their standard deviations are presented in Table 1. Statistical analysis showed significant differences for all individual factors and the triple interactions ($p<0.01$). All double interactions were statistically similar ($p>0.05$). In terms of individual endodontic sealers, Sealer 26 (ΔE = 5.32±4.21) exhibited the lowest ΔE values. Endofill (ΔE = 6.41±6.21), MTA Fillapex (ΔE = 6.88±5.31), and AH Plus (ΔE = 6.98±3.77) exhibited higher ΔE values, which were statistically similar. In terms of tooth region, the largest color change was observed at the cervical third of the root (ΔE = 10.67±5.87). Color changes at the middle third (ΔE = 4.20±2.76) and cervical third of the crown (ΔE = 4.32±2.38) were statistically similar. As for time, the largest ΔE values were observed at T4 (ΔE = 7.72±6.00). Measurements taken at T1 (ΔE = 5.88±3.73), T2 (ΔE = 6.10±5.08), and T3 (ΔE = 5.89±4.72) were similar.

Table 1: Means and standard deviations for ΔE values according to endodontic sealer, tooth region and time

Periods	Regions	Endofill	Sealer 26	AH Plus	MTA Fillapex
T1	CM	3.59 ± 1.86	4.15±1.34	6.59±2.90	3.74±1.21
	CC	4.11±1.19	3.76±1.44	6.70±2.23	3.47±1.77
	R	13.23±5.47	4.64±2.46	8.95±2.88	7.65±1.93
T2	CM	2.70±1.87	3.50±1.91	6.84±4.64	3.47±1.50
	CC	3.05±1.15	3.99±1.47	5.44±2.04	3.04±1.59
	R	16.66±7.50	4.85±2.66	8.67±3.51	10.96±2.74
T3	CM	2.22±1.27	4.11±1.73	4.20±3.14	3.34±1.46
	CC	2.38±1.34	4.19±1.61	5.07±3.31	3.88±2.31
	R	13.96±4.9	5.02±3.04	8.58±3.31	13.68±2.68
T4	CM	2.21±1.14	5.93±3.04	6.14±4.54	4.47±1.74
	CC	2.46±0.99	6.59±3.76	5.30±2.26	5.64±1.85
	R	10.33±3.91	13.07±8.99	11.26±3.73	19.20±2.30

CM, center of tooth crown; CC, crown at 2 mm from the cementoenamel junction; R, root right below the cementoenamel junction.

Discussion

The hypothesis regarding the difference in tooth discoloration between tooth areas was confirmed in this study, since the largest color change was observed at the cervical third of the root. Color changes observed at the middle and cervical thirds of the crown were statistically similar.

Color changes at crown are the most evident and relevant in clinical practice, considering that this dental portion is always visible. However, in case of gingival plastic surgeries are necessary in anterior teeth, the most coronal portion of the root becomes as clinically and esthetically important as the dental crown.

The assessment point located at the cervical third of the root was associated with the highest ΔE values. In this case, discoloration occurred due to the presence of filling material, gutta-percha, and endodontic sealer. Most studies that have evaluated the influence of endodontic sealers on tooth crown discoloration have employed only the endodontic sealer [2, 4, 7, 11, 13, 15]. In the present study, the root canals were prepared and filled using gutta-percha and endodontic sealer, using a technique similar to that used in clinical situations. Gutta-percha is the most common core-filling material used worldwide, but it has been reported to cause a light pink discoloration [8, 18]. The cervical region of the crown exhibited the mildest discoloration, despite the greater quantity and diameter of dentinal tubules [19].

A possible explanation for this result is better cleaning of this region after root canal filling. Tooth discoloration also occurs due to the presence of remaining endodontic sealer inside the dentinal tubules. In the present study, sectioning of the root canal filling was standardized at 2 mm below the cementoenamel junction, and the pulp chamber was cleaned with cotton pellets and alcohol. This protocol differs from several studies that evaluated crown discoloration promoted by endodontic sealers in which only the pulp chamber or part of it was filled with endodontic sealer [2, 5]. Clinically, all sealer remnants should be removed from the pulp chamber during endodontic treatment; however, this does not always occur, and sealer remnants can result in color changes [7].

In the present study, a different protocol was used, in which

the objective was to simulate clinical reality where the endodontic cement should not fill the pulp chamber and should be located below the cementoenamel junction. The hypothesis that the endodontic sealer used for root canal filling may interfere with the color stability of the crown and root was confirmed in this study. Endodontic sealers usually cause color discoloration due to the presence of components that did not react or corrosion of some of these components in the presence of humidity and/or chemical interaction with dentin [7]. Some radiopacifiers such as bismuth oxide - present in some endodontic sealers, including Sealer 26 and MTA Fillapex - trigger a chemical interaction inside the root canal that leads to discoloration tending toward green or black [1, 9]. There are reports in the literature that iron oxide, present in AH Plus, can cause grey discoloration of teeth [12]. Eugenol, present in Endofill, oxidizes and changes color over time, leading to staining of the dental structure [7].

After analysis and comparison of ΔE values, the group filled with Sealer 26 exhibited the mildest discoloration. This result differs from the findings of Meincke *et al.* [4], in which the material exhibited the highest mean ΔE. This difference may be related to the longer evaluation period used here. In the present study, AH Plus demonstrated a similar discoloration level as Endofill, corroborating the finding of Meincke *et al.* [4]. AH Plus is a resin cement containing zirconium oxide as a radiopacifier, a component that is not known to cause tooth discoloration [9]. However, the present study revealed relatively high ΔE values when this sealer was used. This color change was also observed by Thomson *et al.* [18], Meincke *et al.* [4], and Forghani *et al.* [6]. Studies by Lenherr *et al.* [3] and Forghani *et al.* [6] revealed the greatest discoloration occurred during the first three months - which was the study period of the present investigation - and a reduction in ΔE values after this period.

In sum, all endodontic sealers tested induced crown and root discoloration, and Sealer 26 caused the lowest amount of color change. Comparisons between tooth regions revealed that the smallest amount of color alteration was in the cervical third of the root. However, it is important consider that current study used bovine teeth instead of human teeth. Although all similarities, properties differences between human and bovine teeth must be considered when interpreting results obtained from any experiment with bovine teeth substrate [20].

References

1. Ahmed HMA, Abbott PV. Discolouration potential of endodontic procedures and materials: a review. Int Endod J. 2012; 45(10):883-97.
2. Zare Jahromi M, Navabi AA, Ekhtiari M. Comparing coronal discoloration between AH26 and ZOE sealers. Iran Endod J. 2011; 6(4):146-9.
3. Lenherr P, Allgayer N, Weiger R, Filippi A, Attin T, Krastl G. Tooth discoloration induced by endodontic materials: a laboratory study. Int Endod J. 2012; 45(10):942-9.
4. Meincke DK, Prado M, Gomes BPF, Bona AD, Sousa ELR. Effect of endodontic sealers on tooth color. J Dent. 2013; 41(Suppl 3):e93-6.
5. Ioannidis K, Mistakidis I, Beltes P, Karagiannis V. Spectrophotometric analysis of crown discoloration induced by MTA- and ZnOE-based sealers. J Appl Oral Sci. 2013; 21(2):138-44.
6. Forghani M, Gharechahi M, Karimpour S. In vitro evaluation of tooth discolouration induced by mineral trioxide aggregate Fillapex and iRoot SP endodontic sealers. Aust Endod J. 2016; 42(3):99-103.
7. Parsons JR, Walton RE, Ricks-Williamson L. In vitro longitudinal assessment of coronal discoloration from endodontic sealers. J Endod. 2001; 27(11):699-702.
8. Partovi M, Al-Havvaz AH, Soleimani B. In vitro computer analysis of crown discolouration from commonly used endodontic sealers. Aust Endod J. 2006; 32(3):116-9.
9. Walsh LJ, Athanassiadis B. Endodontic aesthetic iatrodontics. Aust Dental Prac. 2007; 18:62-4.
10. Allan NA, Walton RC, Schaeffer MA. Setting times for endodontic sealers under clinical usage and in vitro conditions. J Endod. 2001; 27(6):421-3.
11. Davis MC, Walton RE, Rivera EM. Sealer distribution in coronal dentin. J Endod. 2002; 28(6):464-6.
12. Asgary S, Parirokh M, Eghbal MJ, Brink F. Chemical differences between white and gray mineral trioxide aggregate. J Endod. 2005; 31(2):101-3.
13. Ioannidis K, Beltes P, Lambrianidis T, Kapagiannidis D, Karagiannis V. Validation and spectrophotometric analysis of crown discoloration induced by root canal sealers. Clin Oral Investig. 2013; 17(6):1525-33.
14. Kohli MR, Yamaguchi M, Setzer FC, Karabucak B. Spectrophotometric analysis of coronal tooth discoloration induced by various bioceramic cements and other endodontic materials. J Endod. 2015; 41(11):1862-6.
15. Shokouhinejad N, Nekoofar MH, Pirmoazen S, Shamshiri AR, Dummer PM. Evaluation and comparison of occurrence of tooth discoloration after the application of various calcium silicate-based cements: an ex vivo study. J Endod. 2016; 42(1):140-4.
16. International Commission on Illumination. Recommendations on uniform color spaces, colordifference equations, psychometric color terms. Bureau Central de la CIE, 1978; 15:13.
17. Johnston WM, Kao EC. Assessment of appearance match by visual observation and clinical colorimetry. J Dent Res. 1989; 68(5):819-22.
18. Thomson AD, Athanassiadis B, Kahler B, Walsh L. Tooth discolouration: staining effects of various sealers and medicaments. Aust Endod J. 2012; 38(1):2-9.
19. Costa BM, Iwamoto AS, Puppin-Rontani RM, Pascon FM. Comparative analysis of root dentin morphology and structure of human versus bovine primary teeth. Microsc Microanal. 2015; 21(3):689-94.
20. Yassen GH, Platt JA, Hara AT. Bovine teeth as substitute for human teeth in dental research: a review of literature. J Oral Sci. 2011; 53(3):273-82.