

Review Article

Iatrogenic tooth discoloration by obturating materials: a literature review

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ABSTRACT

Tooth discoloration might constitute a major problem for patients undergoing endodontic procedures, including obturation. Iatrogenic teeth discoloration might be a burden because it is time-consuming and hard to bleach even if it were effective in removing the tooth stains in compared with traumatic tooth discoloration which is easy to deal with. Accordingly, clinicians must have a comprehensive understanding of the potential discoloration effects of the current sealers that are indicated for administration in many of the obturation procedures to enhance the prognosis and the relevant outcomes. In the present study, the aim to conduct a literature review about the potential iatrogenic discoloration effects of some endodontic sealers when conducting obturation procedures, based on the current evidence from the relevant studies. Among the reported agents to induce discoloration, calcium hydroxide, zinc oxide eugenol (ZOE), resin, glass ionomer, and silicon-based sealers have been reported to cause significant degrees of discoloration. Moreover, among the included studies AH-26 seems to be the least significant modality to include discoloration; however, discoloration could still be detected. With the recent technological advances, bioceramic sealers should be able to overcome this problem, especially for areas with the highest esthetic concerns. Accordingly, further investigations might be needed to enhance the quality of the current modalities and to obtain better outcomes.

Keywords: Endodontics, Obturation, Complications, Discoloration, Sealers

INTRODUCTION

Tooth discoloration might constitute a major problem for patients undergoing endodontic procedures, including obturation. Within the past years, many investigations have been published to report on the best efficacious modalities that should be used for obturation and other endodontic procedures to enhance the outcomes and reduce adverse events. Endodontic sealers have been effectively used to reduce inflammation and potential sensitivity, which might occur during obturation. However, tooth discoloration was a common complication following the application of these procedures, which has been previously reported to impact the aesthetic prognosis of these procedures.¹ Previous investigations reported that discoloration might be owing to certain materials as phenol, eugenol, and silver additives.²⁻⁴

Sealers administration has been previously reported to eliminate bacteria and reduce inflammation, and some of them are even biocompatible. However, according to previous reviews, it has been demonstrated that all of the currently reported sealers are significantly associated with tooth discoloration during endodontic procedures and obturation.⁵ Krastle et al also previously reported that teeth-staining is a potential complication with all the currently applied seals in the endodontic procedures. Iatrogenic teeth discoloration might be a burden because it is time-consuming and hard to bleach even if it were effective in removing the tooth stains in compared with traumatic tooth discoloration.^{6,7} Accordingly, clinicians must have a comprehensive understanding of the potential discoloration effects of the current sealers that are indicated for administration in many of the obturation procedures to enhance the prognosis and the relevant outcomes. In the present study, we aim to discuss the potential iatrogenic discoloration effects of some endodontic sealers when conducting obturation procedures, based on the current evidence from the relevant studies.

METHODS

A systematic search was conducted to identify relevant studies in the following databases: PubMed, Medline, Web of Science, Embase, Google Scholar, and Scopus. The following search terms were used: “endodontics” and “iatrogenic tooth discoloration” and “obturation materials”. The reference lists were manually searched to identify additional relevant studies meeting inclusion criteria. We included any study that reports iatrogenic tooth discoloration by obturation material. No restrictions were applied.

DISCUSSION

Glass ionomer and silicon-based sealing

It has been previously demonstrated that these modalities are validated for application in obturation because of their

abilities to achieve monoblock obturation, which is obtainable because of the sealing abilities of the technique leading to significant root canal adhesions.⁸ However, it was also previously reported that they are not hard to remove when a tooth was indicated for retreatment, which may be the main disadvantage of the technique.⁹ A previous investigation by Heling et al previously reported that antimicrobial activities could be observed with Ketac-Endo (3M ESPE, St. Paul, Minnesota).¹⁰ Besides, the evidence related to the potential tooth discoloration following the use of this modality was poor in the literature.

RoekoSeal (Coltène/Whaledent, Langenau, Germany) was previously reported in the literature as a silicon-based sealer as being polydimethylsiloxane, which has been effectively validated because of its proven advantages on inducing slight expansion when applied.¹¹ A short initiation time of the material has been previously reported as being 15 minutes, which might extend to a maximum of half an hour to set. Although previous investigations have previously reported that the modality has shown a great potentiality of being biocompatible, slight delays and sealing inconsistencies have been previously reported as a result of the adjacent use of sodium hypochlorite for irrigation.^{12,13} RoekoSeal has been slightly modified by the addition of some gutta-percha particles to it, resulting in a new polydimethylsiloxane sealing modality that is called GuttaFlow (Coltène/Whaledent Inc, Cuyahoga Falls, OH, USA). A previous investigation by Ioannidis et al previously compared the efficacy of the modality in obturation and their abilities to induce discoloration as compared to previous sealing modalities as Epiphany and AH-26.¹⁴ They reported that following a spectrophotometric analysis, the silicon-based modality was the least to induce discoloration as observed in their sample when compared to the other modalities. Besides, they reported that Roth 811 was also significantly associated with induction of tooth discoloration during obturation.

Resin-based and bioceramic sealing

Previous investigations have also reported on the potential discoloration effects of these modalities during obturation. Resin-based modalities have been reported in use for a long time due to their proven effectiveness and as a result of being free of eugenol. Many substances and techniques have been found in the literature. These include modalities that are methacrylate or epoxy-based sealers including Hybrid Bond Seal (Sun Medical Co. Ltd., Shiga, Japan), EndoREZ (Ultradent Products Inc., UT, USA), and RealSeal (SybronEndo, Orange, CA, USA) for the former and AH-Plus (Dentsply, Tulsa Dental, Tulsa, OK, USA) and AH-26 (Dentsply, Tulsa Dental, Tulsa, OK, USA) for the latter.^{15,16} Most of the published studies have reported that resin-based sealers have a high potentiality of causing discoloration. For instance, a previous in vitro investigation by Zare et al reported that resin-based modalities induced discoloration more significantly than

Dorifill, a zinc oxide eugenol-based modality (ZOE).¹⁷ Meincke et al also previously reported the significant effect of resin-based sealers in the induction of discoloration, when compared to Dorifill and AH-Plus.¹⁸ The same findings were also indicated in the study by Lenherr et al that reported that resin-based sealers showed a higher potentiality of inducing discoloration than the AH-Plus sealer, however, they reported that the modalities' abilities to induce discoloration were poor as compared to another negative control group.¹⁹ Accordingly, as evidence shows the high potentiality of these sealers to induce discoloration, they should be avoided when obturating within the area of esthetics, including the anterior region, and other treatment modalities should be considered. However, if their use was indicated with no suitable alternative, adequate removal and elimination of the remaining filling materials should be removed accordingly.

Bioceramic sealers have been introduced to the field of endodontics because of their wide range of advantages as biocompatibility, bioactivity, and conductivity.²⁰ Previous studies have demonstrated their minimal discoloration activities when compared to other modalities. For instance, Ioannidis et al previously reported that the observed discoloration was significantly minimal with MTA Filapex than what has been observed with Roth 811.²¹

Zinc oxide eugenol sealing

These substances have been previously reported in the literature for a long period as efficacious modalities in the different endodontic techniques. ZOE has been previously favored due to its significant effects in the eradication of bacteria.²² On the other hand, it has been reported that ZOE has been associated to resorb after being extruded into the periradicular tissues, which is the major disadvantage of the modality.²³ Discoloration, solubility, slow setting time, and shrinkage on setting has been previously with sealers as Rickert, Roth's Sealer (Roth International, Chicago, IL, USA), Pulp Canal Sealer EWT (extended working time), and Pulp Canal Sealer, Wach's Sealer, and Roth's Sealer.^{6,24-26} A previous in vitro investigation by Ioannidis et al showed that Roth 811 was significantly associated with more severe coronal discoloration than MTA Fillapex, according to their spectrophotometric analysis.²¹ Moreover, a previous comparative investigation by Meincke et al aimed to assess the effect of many different sealers by comparing them to the Roth 811 sealer.¹⁸ The investigated sealers that were reported in the reported include endomethazone, sealer, endofill, and AH-plus. The authors reported that more significant tooth discoloration was associated with endomethazone and sealer 26 more than all other investigated sealers in the study. Another previous in vitro investigation by Zare et al also investigated whether Dorifill or AH-26 sealers were able to induce more discoloration in their sample.¹⁷ They reported that the latter was associated with more significant discoloration than the former and suggested that ZOE-based sealers can be effectively used for anterior

teeth root canal management based on the findings from their post-treatment of a pre-and four-month period. Another in vitro analysis by Davis et al also reported the effect of using Sealapex, AH-26 (Detrey, Dentsply, Germany), and Roth 801 (Kerr, Romulus, MI., USA) on tooth discoloration using digital imaging-based evaluation approaches.²⁷ They reported that the highest degree of discoloration was associated with using AH-26. However, they also reported that all of the used modalities were able to induce discoloration after few weeks of application, regardless of the type of the used modality. Therefore, it could be concluded that ZOE-based sealers can significantly induce discoloration and therefore, should be used for esthetic treatment zones.

Calcium hydroxide

These sealers were also approached because of their favorable antimicrobial activities. Moreover, it has been previously reported that these modalities might have a potential role as cementogenic-osteogenic modalities.²⁸ However, this suggestion was theoretical and was not clinically validated. An advantageous action of the reported calcium hydroxide-based sealers is the reported solubility which allows for the release of calcium hydroxide and also gives the modality a favorable action with prolonged effectiveness.^{28,29} Nevertheless, it was reported that it could be noticed that the mechanism by which the modality acts is inconsistent with its main purpose of being a sealer.²⁹ Various calcium hydroxide-based modalities have been reported in the literature and include calciobiotic root canal sealer (CRCS, Hygienic, Akron, OH, USA), Apexit and Apexit Plus (Ivoclar Vivadent, AG, Schaan, Liechtenstein), and Sealapex (SybronEndo Corporation, Orange, CA, USA) sealers. A previous in vitro investigation by Parsons et al previously evaluated some calcium hydroxide-based sealers using digital imaging modalities to evaluate their abilities to discoloration the underlying teeth.⁴ After evaluation of AH-26, Roth 801, Kerr Pulp Canal, and Sealapex sealers were all associated with moderate and mild degrees of discoloration that was also noticed to be progressive over the 12 month follow-up period. Moreover, they reported that AH-26 sealers were associated with the significantly highest discoloration frequencies as compared to the other modalities. Another investigation by El Sayed et al also concluded that Apexit Plus sealer was associated with the least estimated discoloration frequencies.³⁰ On the other hand, Sultan (which is a ZOE-based sealer, Sultan Chemist Inc, Englewood, NJ, USA), and AH-26 were both significantly associated with higher frequencies of coronal discoloration that was also noticed to be increasing in about 10-17 days following the procedure. A previous in vitro investigation by Davis et al also compared various sealers including AH-26, Roth 801, Kerr Pulp Canal Sealer, and Sealapex sealers, and evaluated their filling efficacy and ability of discoloration of the relevant teeth using digital imaging modalities for evaluation.²⁷ They reported that all groups were not significantly associated with measurable penetration in dentin and with no apparent

discoloration. Nevertheless, they reported that some notable discoloration was observed within the bulk of the sealer, and after two years, they also noticed that the pulp chamber was the only significant area that the discoloration is apparent.

CONCLUSION

Our present review has discussed the potential discoloration effect of some substances that are used in endodontics and obturation. Among the reported agents to induce discoloration, calcium hydroxide, ZOE, resin, glass ionomer, and silicon-based sealers have been reported to cause significant degrees of discoloration. Moreover, among the included studies AH-26 seems to be the least significant modality to include discoloration. However, discoloration could still be detected. With the recent technological advances, bioceramic sealers should be able to overcome this problem, especially for areas with the highest esthetic concerns. Accordingly, further investigations might be needed to enhance the quality of the current modalities and to obtain better outcomes.

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