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## DIFFERENCES IN TOOTH DISCOLORATION BETWEEN ZINC OXIDE EUGENOL AND MINERAL TRIOXIDE AGGREGATE-BASED SEALERS (LITERATURE STUDY)

Dentistry

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### ABSTRACT

Endodontic treatment is a common procedure in dentistry. One of the steps in endodontic treatment is obturation root canal, that needed application sealer to seal the gap between dentin's wall and gutta-percha and lubricate the root canal's wall during treatment. Sealer can cause discoloration because of their compositions such as eugenol, phenol, and silver that is potential in causing color alteration. Objective: to analyze the discoloration difference in application using ZOE sealer and MTA sealer. Method: Journals, textbooks, and websites published between 2010 – 2020 and can be accessed from Google Scholar, National Library of Indonesia, EBSCO, and PubMed are used as source of this literature review. Conclusion: Both of the sealer cause discoloration because of their composition such as zinc oxide and eugenol that caused continuous oxidation in ZOE sealer and bismuth oxide which interacts with dentin in MTA sealer. Application of MTA is recommended because of their minimal color alteration compared to ZOE sealer, and their excellent physical properties and biocompatibility.

### KEYWORDS

Discoloration, Sealer, Mineral Trioxide Aggregate, Zinc Oxide Eugenol

### INTRODUCTION

Anterior teeth significantly influence a person's appearance because they are located in the aesthetic zone and are the first teeth seen when someone smiles. According to Naveh, quoted by Anwar<sup>1</sup> stated that 37.3% of research subjects were dissatisfied with the appearance of their teeth, and 90% of the reasons were dissatisfaction with the color of the teeth.<sup>1</sup>

Discolored anterior teeth will be a concern and affect the patient's social life. Several causes of discolored anterior teeth include traumatic, non-vital injuries, endodontic treatment, and restoration stages.<sup>2</sup> The final stage in the endodontic treatment procedure is root canal filling to prevent the spread of bacteria from the root to the crown. Filling the root canal using a sealer with filling material is to fill the root canal. The sealer is necessary to seal the space between the dentine wall and the filling material, which is gutta-percha. The sealer also acts as a lubricant during root canal filling.<sup>3</sup> Root canal treatment causes discoloration due to pulp remnants, micro-leakage of restorative material, internal absorption, and treatment failure root canal. Sealer-induced tooth discoloration after endodontic treatment, affecting the aesthetic results.<sup>3</sup>

Discoloration of the teeth results from using a sealer that spreads to the dentinal tubules; components such as eugenol, phenol, and silver are likely to cause coronal discoloration.<sup>3</sup> A current study is a comparison of discoloration using root canal sealers based on zinc oxide eugenol and mineral trioxide aggregate. The study is mainly done with controversial results. Some researchers stated that the use of sealer made from zinc oxide eugenol (ZOE) experienced more significant discoloration than mineral trioxide aggregate (MTA). Other researchers argue that MTA-based root canal sealers show discoloration comparable to ZOE-based ones.<sup>4</sup>

Ioannidis et al. (2013) stated that MTA Fillapex did not cause clinically visible crown discoloration.<sup>4</sup> ZOE-based sealer (Roth 811) causes rapid discoloration and critical. MTA has chromogenic potential but MTA Fillapex has minimal risk for discoloration effects. In terms of aesthetics, the use of Fillapex MTA is more beneficial.<sup>5</sup>

According to Ekici et al. (2019), who tested the ZOE-based sealer (*pulpispad*) and MTA Fillapex, the potential for color change in *pulpispad* sealer was not much different from MTA Fillapex at 1 month and 1 year.

However, *pulpispad* showed faster and more critical discoloration than MTA Fillapex because of relatively unstable zinc oxide eugenol bonds. ZOE chemically changes (oxidizes) and darkens teeth over time. The content in the pulp pad that can affect the discoloration of the teeth is silver.<sup>6</sup>

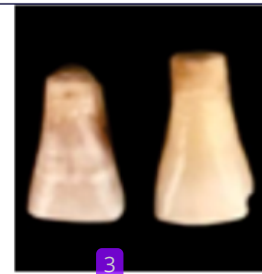


Figure 1. Teeth applied with ZOE-based sealer (left) and MTA-based sealer (right).<sup>9</sup>

The difference between the results of previous studies prompted researchers to compile a literature study of differences in tooth discoloration when using a sealer made from zinc oxide eugenol and mineral trioxide aggregate after root canal treatment.

### Method

This literature review was based on reference sources with the keywords 'zinc oxide eugenol sealer, mineral trioxide aggregate, discoloration' obtained from journals, textbooks, and websites accessed through the Google Scholar database, National Library of Indonesia, EBSCO, and PubMed. The reference journals were case-control, case reports, accredited research, and descriptive journals published from 2010-2020.

### RESULTS

#### Root Canal Treatment

Root canal treatment (PSA) is a part of dental conservation treatment that aims to maintain pulp vitality, treat damaged teeth and pulp necrosis, and teeth that have failed previous treatment so they can continue to function. Therefore, the main goal of root canal treatment is to create an environment within the root canal system that allows healing and maintenance of the periradicular tissues.<sup>7</sup> Root canal treatment aims to eliminate pulpal and periapical diseases and repair diseased tissue. Root canal treatment divides into 3 stages, namely the biomechanical preparation stage of cleaning and shaping the root canal by opening the entrance to the pulp chamber from the coronal direction; the sterilization stage by irrigation and root canal disinfection, as well as the root canal filling stage. The success of root canal filling depends on asepsis, thorough pulpal cleaning, biomechanical preparation, and hermetic root canal filling.<sup>8</sup>

#### Root Canal Filling

"Obturation" means blocking, obstructing, closing, or filling a cavity. Historically, root canal obturation was the most crucial part of overall

root canal treatment.<sup>9</sup> The American Endodontic Association states, "Obturation is a method used to fill and seal root canals that have been cleaned and shaped using root canal sealer and core filling material." The function of root canal filling is to fill the root canal and eliminate all ingress between the periodontium and the root canal; the better the sealing ability, the better the prognosis.<sup>10</sup>

The ideal filling is as complex as the anatomy of the root canal itself. The root canal filling must cover all foramen leading to the periodontium, and the ideal filling must be solid, attached to the canal wall, and hermetic. According to Naidorf, quoted by Chandra<sup>10</sup>, inadequate obturation of the crown causes the root canal to open to the periapical tissue fluid, which provides a pathway for the growth of microorganisms. According to a study by Ingle and Beveridge, 58% of endodontic failures could be attributed to incomplete root canal obturation.<sup>10</sup>

#### Root Canal Filling Material and Gutta-percha

Root canal filling materials are used to prevent infection in the root canals after sterilization, and the periradicular tissue<sup>11</sup>. The filling materials used in root canal treatment consist of solid and semisolid filling materials. The leading fillers that can be used include gutta-percha, mineral trioxide aggregate (MTA), and silver resilon, where the fillers are selected according to the indications for treatment.<sup>12</sup>

Gutta-percha is a pure sap liquid that can harden and comes from compacted Sapotaceae trees. Gutta-percha is chemically an isoprene-based polymer.<sup>13</sup> Gutta-percha has been used in endodontics as the primary filling material for more than 100 years, which is used in dentistry consisting of 19–22% trans-polyisoprene and 59–75% zinc oxide filler with other additives, such as wax or resin, which increases the plasticity of the material and there are metal salts, which are used to improve radiodensity. Combining gutta-percha with zinc oxide can inhibit bacterial growth, while calcium hydroxide can stimulate apex and osteogen closure.<sup>11</sup>

#### Root Canal Sealer

The root canal sealer is used with the primary filling material, gutta-percha. The main function of the sealer is to close the gap between the gutta-percha and the root canal wall. Current root canal filling techniques use the sealer to increase the density of the root canal. Root canal sealers are used to cement (luting) the core material to the canal and additional root canal filling materials, absorption abnormalities, and spaces not filled with gutta-perch.<sup>12</sup>

The ideal conditions for a sealer, according to Grossman, are that there is no shrinkage during hardening, it is adhesive because the truly adhesive material will form a strong bond between the core material and the dentin so that it can close the existing cavities, is radiopaque, does not color the teeth, dissolves in solvents, bactericidal, non-irritating to periradicular tissues and insoluble in oral tissue fluids.<sup>12</sup>

#### Zinc Oxide Eugenol

Zinc oxide is a significant component of various sealers used in endodontics. Grossman's Sealer, Roth's 801 Sealer, the most commonly used sealers, and Rickert's. Grossman's Sealer contains zinc oxide eugenol, staybelite resin, bismuth subcarbonate, barium sulfate, and sodium borate with eugenol as the liquid component.

Roth's 801 sealer is similar to Grossman's sealer, containing bismuth subnitrate instead of bismuth subcarbonate.<sup>14</sup>



Figure 2. Endomethasone N Sealer<sup>15</sup>

The advantages of ZOE cement include having sufficient working time, providing pulp protection, minimizing microleakage, reducing pulpitis pain, antimicrobial, and preventing pulp injury. ZOE sealer

have disadvantages, namely that they can cause discoloration of teeth, contain eugenol which poses an allergic risk to patients, have a risk of abrasion, and are easily dissolved in oral fluids. Various types of filling materials have different hardening times and flow characteristics. In complex root canal fillings, these materials have a slow hardening time.<sup>15</sup>

#### Mineral Trioxide Aggregate

The most recent innovation in sealers is the calcium silicate / MTA-based material, and this material exhibits strong, biocompatible properties due to its high pH and ability to form hydroxyapatite<sup>16</sup>. MTA is a form of the main compound, Portland cement (PC). These new types of bioceramic sealers are ProRoot Endo sealers (Dentsply Maillefer, Ballaigues, Switzerland), MTA Fillapex (Angelus, Londrina, Brazil), MTA Obtura (Angelus), and others.<sup>12</sup>



Figure 3. Mineral Trioxide Aggregate<sup>17</sup>

MTA has the potential to be a multifunctional material, namely pulp capping, pulpotomy, apexification, root perforation repair (surgical and non-surgical), sealer, and root canal filling. During endodontic treatment of primary and permanent teeth, MTA can be used in various ways, for instance, as an apical and furcation restorative material and as a medicament for treating apexogenesis and apexification, repair of resorbing lesions and as retrograde obturation<sup>16</sup>. The advantages of MTA are that it contains hydrophilic particles and good sealing ability, is biocompatible, and has anti-bacterial and anti-fungal effects. This material has a good sealing ability compared to conventional materials used in root canal treatment. MTA, when used as a root MTA canal obturator, has physicochemical properties that can provide good results as a root canal obturator. MTA has disadvantage, including, long setting time, discoloration, and can affect aesthetic value.<sup>18,19</sup>

#### Discoloration

Dental discoloration is a discoloration of teeth caused by several etiological factors, namely intrinsic and extrinsic factors that can occur in vital and non-vital teeth. Extrinsic discoloration, such as surface stains, is easy to remove while intrinsic discoloration occurs below the surface within the enamel and dentin of the crown and can be difficult to remove. Discoloration has different appearances, locations and severity. This change occurs as a result of sealer compounds spreading to the dentinal tubules during or after hardening, certain components such as eugenol, phenol and silver cause coronal discoloration.<sup>20</sup>

Discoloration is the main cause of dental aesthetic treatment. Several factors contribute to tooth discoloration, such as intrinsic or extrinsic factors. Discoloration occurs as a result of endodontic treatment caused by obturation materials. Studies have identified different types of tooth discoloration.<sup>21</sup>

#### DISCUSSION

Root canal treatment is one of the treatments in dentistry that is commonly carried out by the public. One of the public complaints that dentists often encounter is the discoloration of the teeth that occur after root canal treatment. Discoloration or discoloration on the teeth is caused by various factors, one of which is caused by root canal sealers, such as zinc oxide eugenol and mineral trioxide aggregate.

Tooth discoloration generally occurs in the cervical third of the tooth crown because of the thin tooth enamel structure and its translucent color.<sup>4</sup> Based on research by Savadkouhi et al., 44 pieces of literature on discoloration in endodontic procedures, it was found that no results showed significant discoloration due to the use of sealers in root canal treatment.<sup>22</sup>

Sealer zinc oxide eugenol or ZOE has advantages in its properties, namely intense antibacterial activity, but can be absorbed by the



periradicular tissue. The mineral trioxide sealer aggregate has advantages in its function as a sealer, namely its bioactivity, and biocompatibility. The two sealers have an identical drawback, which can cause discoloration. Research Savadkouhi et al. stated that a sealer based on zinc oxide eugenol had a low ability to cause discoloration in root canal treatment and was suitable for root canal treatment. On the other hand, mineral trioxide aggregate-based sealer causes discoloration of the cervical third of the teeth, so using aggregate mineral trioxide sealer is more appropriate for use on posterior teeth because posterior teeth do not prioritize aesthetic aspects. Savadkouhi et al. suggest being careful in the use of sealer to avoid interference with dental aesthetics.<sup>22</sup>

Based on research by Meincke et al. in 2012 regarding the effect of using sealers on tooth color, the conclusion was drawn that each sealer in the endodontic area will lead to significant color changes after being applied for 6 months. The samples in this study were 40 incisors and canines that had been extracted and were free of caries, restorations, cervical lesions, and discoloration on the crowns. The samples were divided into four different treatment groups. The root canals of the sample teeth were prepared using K-file using the step-back technique with sodium hypochlorite and 17% EDTA for three minutes. After irrigating and drying, the root canals were treated with gutta percha and different sealers, i.e. Sealer 26, Endophil, Endomethasone N, and AH Plus. Based on observations after the first 24 hours, only the AH Plus sealer had an acceptable color change compared to the other 3 sealers. One of the sealer that has the same content as AH Plus, AH 26, also makes visible discoloration on the tooth crown. The discoloration caused by the sealer is not because the sealer contains silver or heavy metals, but because the substances contained in the sealer can discolor dentin such as calcium hydroxide and iodine. Eugenol will also oxidize with zinc oxide over time and form discoloration.<sup>23</sup>

The literature study by Krastl et al. (2013) showed that almost all endodontic treatment materials cause discoloration of teeth. One study stated that Kerr Pulp Canal's zinc oxide eugenol-based sealer causes discoloration of the crown because the sealer contains silver ions. Other literature cited by Krastl et al. states that white MTA causes discoloration due to the content of bismuth oxide to add radiopaque properties to the sealer. The conclusion is that discoloration will occur with any endodontic material used by dentists, but can be prevented by its application to areas that do not affect the aesthetics of the tooth.<sup>24</sup>

Research by Ioannidis et al. (2013) regarding spectrophotometric analysis of crown discoloration triggered by MTA and ZOE-based sealers showed that, MTA Fillapex, caused less discoloration than another sealer, Roth 811. Based on the results of the study, the ZOE-based sealer Roth 811 caused a rapid and severe discoloration of the teeth. Roth 811 sealers over time will continue to cause discoloration of the teeth due to the oxidation mechanism it undergoes. MTA Fillapex has the advantages of antibacterial ability and good density. In addition, MTA Fillapex may not cause discoloration as severely and quickly as Roth 811. MTA Fillapex sealers can be an alternative in the use of sealers.<sup>25</sup>

Another study by Ekici et al. examined the effect of sealer discoloration over a longer period of three years. The ZOE-based sealer used was Pulpispad brand and the MTA-based sealer was Fillapex brand. This study showed that ZOE-based sealer caused more discoloration than MTA-based sealer after month 1, year 1, and year 3 as measured by spectrophotometer. ZOE-based sealer experienced more severe discoloration because the zinc oxide bond with eugenol was unstable and oxidized over time and darkened in color. Pulpispad brand sealer also contain silver, which contributed to the darkening of the teeth to which they were applied. Teeth applied with the MTA-based sealer, Fillapex, also caused discoloration due to its bismuth oxide content. Bismuth oxide reacting with dentin components can cause oxidation and turn them into pigmented end products. This study suggests that dentin thickness may influence the discoloration caused by MTA-based sealer.<sup>6</sup>

ZOE-based sealer can cause significant tooth discoloration based on several studies due to their eugenol content which oxidizes with zinc oxide and will increase in discoloration over time. MTA-based sealer cause discoloration as well because MTA-based sealers contain bismuth oxide which can oxidize and cause discoloration. Both MTA- and ZOE-based sealer cause discoloration, but this can be counteracted by using them to match the location of teeth that do not require

aesthetics, such as posterior teeth. Based on the studies cited, MTA-based sealer are better to use because they cause less potential discoloration, and MTA-based sealer have better physical properties and biocompatibility than ZOE-based sealer.

## CONCLUSIONS

Based on the previous discussion, it can be summarized that overall the use of MTA-based sealer is more recommended for treatment, because the potential for discoloration is minimized compared to ZOE-based sealer, and MTA-based sealer has good physical properties and biocompatibility. ZOE-based sealer likely causes discoloration due to the unstable chemical bond between zinc oxide and eugenol resulting in a continuous oxidation process that leads to a darker color over time, while MTA-based sealer is likely to cause discoloration due to the chemical interaction between bismuth oxide and dentin.

There are several limitations in this literature review and research, so the author expects future researchers to conduct further research on discoloration caused by MTA-based sealer and ZOE-based sealer, by using more tooth samples, as well as the same dentin thickness so that the treatment given is equivalent between teeth with MTA or ZOE-based sealer.

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