Sealing ability of zinc oxide eugenol and non-eugenol-based temporary filling

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Abstract. Sealing ability is an important property for temporary filling. This study aimed to determine the sealing ability of zinc oxide eugenol and non-eugenol-based temporary filling by performing the dye penetration test. In total, 20 extracted maxillary premolars were filled with four different temporary fillings, such as intermediate restorative materials (IRMs), zinc oxide eugenol cement, Caviton, and Dentorit. The filled premolars were subsequently immersed in 1% methylene blue for 5 days and evaluated under stereomicroscope Nikon SMZ800 (magnification, 63×). The Kruskal–Wallis statistical test revealed that zinc oxide non-eugenol-based temporary filling shows a better sealing ability than zinc oxide eugenol-based temporary filling, with a significance level of 0.002 (p<0.05).

1. Introduction
Temporary restoration is used in dental care when a treatment cannot be completed within a single visit, such as root canal treatment, or when waiting for a permanent restoration to be completed. Generally, temporary materials have relatively low tensile strength because these dense materials are only temporarily used, ranging from 5 to 7 days, for easy lifting, and they are easy to manipulate and do not irritate the pulp. Currently, some temporary materials require manipulation, which need to be mixed in advance with powdered liquids, such as zinc oxide eugenol (ZOE) cement, intermediate restorative material (IRM), and zinc phosphate cement, while some ready-made pastes do not require manipulation, such as non-eugenol zinc oxide paste with trademarks Caviton (GC Asia, Singapore, Singapore) and Dentorit (Dentoria, French) [1, 2].

Temporary restoration can either contain eugenol or non-eugenol temporary fillings. ZOE and IRM cements are temporary restorative materials containing eugenol. Eugenol is bactericidal, a substance that can interfere even with the growth of dead trapped bacteria or in the restoration, however, its side effect, that is the sensation of warmth when exposed to the oral mucosa, can irritate the pulp. The temporary non-eugenol loads on the market are Caviton and Dentorit among others [3].

One of the key requirements for a temporary filling material is a good sealing ability. Sealing ability is closely related to the ability of the material to adapt to the tooth walls. Temporary layers that can enter wall irregularities in the enamel or dentin do not shrink after hardening, and the absence of trapped air in the sphere results in temporary sealing with good sealing ability. Thus, sealing ability is
important in temporary restoration to prevent bacterial reinfection in the cavity and to inhibit the entry of bacteria from the oral cavity into the tooth cavity [2, 4].

The properties of zinc oxide include dimensionally poor stability; hence, it easily contracts when the temperature changes [5]. This may affect the sealing ability of the zinc oxide-based temporary restoration. To date, no study has compared the sealing ability of eugenol- and non-eugenol-containing temporary tincture-based zinc oxide-based restoratives that are commercially available. Considering this, this study aimed to compare the sealing ability between eugenol- and non-eugenol-based zinc oxide temporary restoration.

2. Methods
This research is a laboratory experimental study using 20 upper premolar teeth extracted due to orthodontic indications as specimens, which were immersed in aquabides. These specimens were obtained from Aji Waras Tooth Clinic, and this study was approved by the Dental Research Ethics Committee, Faculty of Dentistry, Universitas Indonesia. On the specimens cavities were prepared with a depth of 4 mm, width of 2 mm, and length of 3 mm. The specimens were divided into four treatment groups (5 specimens per group according to ANSI (American National Standards Institute) /ADA (American Dental Association) Specification No. 30), which were subjected to IRM, ZOE cement, Caviton, and Dentorit treatments.

After all teeth were prepared, the restoration material was temporarily manipulated according to the manufacturer's instructions. The restoration material was temporarily incorporated into the cavity using plastic filling and cement stopper. After the procedure was completed, the specimen was placed into the aquadest for 1 h to properly harden and solidify.

After hardening, the entire tooth surface was coated with transparent nail polish except for 1 mm around the edges of the crater. The root tip of the tooth was covered with an evening candle and coated with transparent nail polish to prevent the dye from penetrating through the root canal. The specimen was then immersed in 1% methylene blue for 5 days.

The specimen was then divided in a mesiodistal direction with a specimen dental sterilizer (Streus Accutom-Z) equipped with cooling water, then examined under a stereomicroscope (Nikon SMZ800) with a 63× magnification to visualize the penetration of 1% methylene blue dye into the micro-slit between the walls of restoration and teeth. The penetration of the 1% methylene blue dye into the microspector was assessed by the following scoring criteria: score 1, if the dye penetrated 2.5–4 mm from the cavity surface; score 2, if the dye penetrated 1.5–2.5 mm from the cavity surface; and score 3, if the dye was located only on the surface up to 1.5 mm from the surface of the cavity.

There were two observants recording the scoring. Data obtained from both observants were tested for reliability with Kappa coefficient and then analyzed with Kruskal–Wallis test. A p value of 0.05 (p=0.05) was considered significant at a 95% confidence level (α=0.05).

3. Results
The visualization of the treatment groups under Steromicroscope can be observed in Figure 1. The scores of all the treatment groups are summarized in Table 1. After the reliability test, kappa inter-observation coefficient of 0.774 shows good reliability between the two observations. The Kruskal–Wallis test revealed a significant difference between the temporary cure group based on ZOE (cement ZOE and IRM) and non-eugenol (Caviton and Dentorit) (p = 0.002).
Figure 1. Temporary Restoration Observation Results using Steromicroscope with 63× Magnification

Table 1. Results of Temporary Restoration in Methylene Blue Penetration 1% (5 days immersion)

| Zinc Oxide Temporary Restoration Material | N  | 1 | 2 | 3 |
|------------------------------------------|----|---|---|---|
| Observant 1                             |    |   |   |   |
| non-eugenol                              | 10 | 4 | 6 |
| Cavition                                 |    | 2 | 3 |
| Dentorit                                 | 5  | 2 | 3 |
| eugenol                                  |    | 7 | 3 |
| ZOE                                      | 5  | 5 | - |
| IRM                                      | 5  | 2 | - |
Table 1. Continue

| Observant 2 |   |   |
|-------------|---|---|
| non-eugenol | 4 | 6 |
| Caviton     | 5 | - |
| Dentorit    | 5 | 2 |
| eugenol     |   | 2 |
| ZOE         | 5 | 5 |
| IRM         | 5 | 1 |

Index:
- Scoring 1 = liquid dye penetrating 2.5-4 mm from the surface of the cavity
- Scoring 2 = liquid dye penetrating 1.5-2.5 mm from the surface of the cavity
- Scoring 3 = liquid dye is only on the surface up to 1.5 mm from the surface of the cavity.

4. Discussion

The method used in this research, sealing ability testing using dye, provided semi-quantitative results; hence, the results obtained from this study can only show the comparison between the materials used, such as temporary tincture-based ZOE and non-eugenol, and the results were not absolute [6].

The results of this study indicated that the temporary restoration using ZOE had a worse sealing ability compared with that using zinc oxide non-eugenol spill. The commercially available temporary restoration zinc oxide non-eugenol-based materials, such as Caviton and Dentorit, are available as ready-to-use pastes and are hydraulic materials that will gradually harden and begin hardening when water is available in the surrounding environment. Temporary fillings that include hydraulic materials have good sealing ability because of hydrophobic components formed during the hardening process that block water entry into the cavity. Therefore, zinc oxide non-eugenol-based temporary restorative materials have better sealing abilities than temporary ZOE-based restorative materials not included in the hydraulic material group [5, 7].

ZOE and IRM cements are available as powders and liquids, and they need to be manipulated based on the manufacturer’s instructions. The results of the manipulation produce a cement with low viscosity, making it difficult to manipulate when it is condensed into the cavity. This has led to the difficulty of obtaining good adaptation between tooth tissue and congestion. The dimensional changes in the temporary hardening process of ZOE-based restoration were also greater than the temporary non-eugenol-based zinc oxide-based spill [8].

The zinc oxide non-eugenol temporary restoration using Caviton and Dentorit in this study has similar compositions, which causes both to have sealing abilities that are similar [9, 10]. The ZOE and IRM cement in this study had different sealing abilities. IRM showed a better sealing ability than ZOE cement. In previous study about the property of temporary restoration, the disintegration of IRM has been shown to be less than that of ZOE cement. Such smaller IRM disintegration value compared with ZOE cement indicates that IRM is more difficult to dissolve in water than ZOE cement. This is because IRM contains poly-methyl methacrylate as reinforcing material that is difficult to dissolve in water [11]. Although the disintegration of ZOE cement is of great value because of the decomposition of zinc eugenolate into zinc hydroxide and eugenol; zinc eugenolate has a weak and easily hydrolyzed bond with water [8, 12].

On the basis of these findings, we recommend that temporary zinc oxide non-eugenol-based materials, such as Caviton and Dentorit, should be clinically used as short-acting ZOE-based temporary materials (5–7 days) owing to their better sealing ability. However, the IRM is the best choice for the long-term use of temporary retention because it has sufficient sealing ability, the least disintegration value based on a previous research, and the greatest compressive strength compared with Dentorit and ZOE [12].
5. Conclusion
Temporary non-eugenol-based zinc oxide (Caviton and Dentorit)-based restorative materials have better sealing ability than ZOE- and IRM-based temporary restorative material. Due to the limited time and quantity of specimens in this study, conducting further research on the sealing ability of transient sediments based on ZOE and non-eugenol temporary restoration is imperative, with longer immersion time and varied dye solutions to investigate the association between sealing ability with immersion time.

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