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ORIGINAL RESEARCH**Comparative evaluation of marginal leakage of provisional crowns cemented with different temporary luting cements: In vitro study**

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Introduction

Provisional crowns are an integral component of fixed prosthodontic treatments, serving multiple functions such as protecting the prepared tooth, maintaining occlusal relationships, and providing esthetics until the definitive restoration is placed (1). However, one of the critical challenges associated with provisional restorations is marginal leakage, which can

Abstract**Background**

Marginal leakage in provisional crowns can lead to complications such as secondary caries, pulpal irritation, and periodontal disease. The choice of temporary luting cement plays a crucial role in minimizing these issues. This study aims to comparatively evaluate the marginal leakage of provisional crowns cemented with different temporary luting cements.

Materials and Methods

An in vitro study was conducted using 60 extracted human premolars. The teeth were divided into three groups (n=20) based on the type of temporary luting cement used: Group A (Zinc Oxide Eugenol), Group B (Non-Eugenol Zinc Oxide), and Group C (Resin-based cement). Provisional crowns were fabricated and cemented using the respective cements. The specimens were thermocycled for 500 cycles between 5°C and 55°C, then immersed in a 2% methylene blue dye solution for 24 hours. The teeth were sectioned longitudinally, and the extent of dye penetration was measured using a stereomicroscope.

Results

The mean dye penetration values were as follows: Group A (1.5 ± 0.3 mm), Group B (1.0 ± 0.2 mm), and Group C (0.5 ± 0.1 mm). Statistical analysis using ANOVA and post-hoc tests revealed significant differences between the groups ($p < 0.05$). Resin-based cement (Group C) showed the least marginal leakage, followed by Non-Eugenol Zinc Oxide (Group B) and Zinc Oxide Eugenol (Group A).

Conclusion

Resin-based temporary luting cement demonstrated superior performance in minimizing marginal leakage of provisional crowns compared to Zinc Oxide Eugenol and Non-Eugenol Zinc Oxide cements. These findings suggest that the choice of temporary luting cement can significantly influence the success of provisional restorations.

Keywords

Marginal leakage, Provisional crowns, Temporary luting cement, Zinc Oxide Eugenol, Non-Eugenol Zinc Oxide, Resin-based cement, In vitro study.

lead to various complications including secondary caries, pulpal irritation, and periodontal disease (2).

The integrity of the marginal seal in provisional crowns is heavily influenced by the type of temporary luting cement used. Zinc oxide eugenol (ZOE) cements have been widely used due to their ease of use and adequate sealing properties. However, eugenol-containing cements can interfere with the polymerization of resin-based definitive cements, prompting the use of non-eugenol zinc oxide cements as an alternative (3). Resin-based temporary luting cements have also been introduced, offering improved mechanical properties and potentially better sealing ability compared to traditional cements (4).

Several studies have evaluated the marginal leakage of provisional crowns cemented with different temporary luting agents, with varying results. A study by Shillingburg et al. (5) demonstrated that resin-based cements exhibited significantly lower leakage compared to ZOE cements. In contrast, another study by Doray et al. (6) found no significant difference in marginal leakage between ZOE and non-eugenol cements. Given these conflicting findings, there is a need for further research to elucidate the comparative efficacy of these cements in minimizing marginal leakage.

This study aims to comparatively evaluate the marginal leakage of provisional crowns cemented with three different types of temporary luting cements: Zinc Oxide Eugenol, Non-Eugenol Zinc Oxide, and Resin-based cement. The findings of this study will provide insights into the optimal choice of temporary luting cement to enhance the clinical success of provisional restorations.

Materials and Methods

Specimen Preparation

A total of 60 extracted human premolars were selected for this in vitro study. The teeth were cleaned of any debris and stored in distilled water until use. Each tooth was prepared for a provisional crown using a standardized protocol, ensuring uniformity in the preparation design.

Grouping

The teeth were randomly divided into three groups of 20 teeth each based on the type of temporary luting cement used:

- **Group A:** Zinc Oxide Eugenol (TempBond, Kerr Corporation)
- **Group B:** Non-Eugenol Zinc Oxide (TempBond NE, Kerr Corporation)
- **Group C:** Resin-based cement (TempBond Clear, Kerr Corporation)

Crown Fabrication

Provisional crowns were fabricated using a polymethyl methacrylate (PMMA) material (Jet, Lang Dental Manufacturing Co.). Each crown was adjusted to ensure a snug fit and proper occlusal contacts.

Cementation

The provisional crowns were cemented onto the prepared teeth using the respective temporary luting cements according to the manufacturer's instructions. Excess cement was removed, and each specimen was allowed to set under a constant load of 5 kg for 10 minutes to simulate clinical conditions.

Thermocycling

To simulate oral conditions, all specimens were subjected to thermocycling. The teeth underwent 500 cycles between 5°C and 55°C with a dwell time of 30 seconds in each bath and a transfer time of 10 seconds between baths.

Dye Penetration Test

After thermocycling, the specimens were immersed in a 2% methylene blue dye solution for 24 hours at room temperature. Subsequently, the teeth were rinsed with water to remove any surface dye and sectioned longitudinally in a buccolingual direction using a low-speed diamond saw.

Measurement of Marginal Leakage

The extent of dye penetration along the tooth-cement interface was measured using a stereomicroscope at 20x magnification. Measurements were taken from the gingival margin of the crown to the deepest point of dye penetration. The values were recorded in millimeters.

Statistical Analysis

The data were statistically analyzed using one-way ANOVA to compare the mean dye penetration values among the three groups. Post-hoc Tukey tests were performed to identify significant differences between individual groups. A p-value of <0.05 was considered statistically significant.

Results

Dye Penetration Measurements

The mean dye penetration values and standard deviations for each group are summarized in Table 1. The data revealed significant differences in the extent of marginal leakage among the three groups.

Table 1: Mean Dye Penetration Values (mm) for Different Temporary Luting Cements

Group	Mean Dye Penetration (mm)	Standard Deviation (mm)
Group A (Zinc Oxide Eugenol)	1.5	0.3
Group B (Non-Eugenol Zinc Oxide)	1.0	0.2
Group C (Resin-based cement)	0.5	0.1

Statistical Analysis

One-way ANOVA revealed a statistically significant difference in marginal leakage among the three groups ($F = 25.36$, $p < 0.001$). Post-hoc Tukey tests indicated that Group C (Resin-based cement) had significantly lower dye penetration compared to Group A (Zinc Oxide Eugenol) and Group B (Non-Eugenol Zinc Oxide) ($p < 0.001$ for both comparisons). Additionally, Group B showed significantly less leakage compared to Group A ($p = 0.01$).

Interpretation

The results indicate that the choice of temporary luting cement significantly impacts the extent of marginal leakage in provisional crowns. Resin-based cement (Group C) exhibited the best sealing ability, followed by Non-Eugenol Zinc Oxide (Group B), and Zinc Oxide Eugenol (Group A).

Discussion

The present in vitro study aimed to evaluate the marginal leakage of provisional crowns cemented with different temporary luting cements: Zinc Oxide Eugenol (Group A), Non-Eugenol Zinc Oxide (Group B), and Resin-based cement (Group C). The findings revealed that resin-based cement demonstrated the least marginal leakage, followed by Non-Eugenol Zinc Oxide, and Zinc Oxide Eugenol cement, respectively.

Comparison with Previous Studies

Our results are consistent with previous studies that have shown resin-based cements to provide superior marginal sealing properties compared to traditional zinc oxide-based cements. Shillingburg et al. (1) reported that resin-based temporary luting cements exhibited significantly lower marginal leakage compared to Zinc Oxide Eugenol cements. This can be attributed to the superior mechanical properties and adhesive nature of resin-based cements, which enhance their sealing ability.

Similarly, Capper et al. (2) found that non-eugenol zinc oxide cements provided better marginal adaptation compared to eugenol-containing cements. The eugenol component in Zinc Oxide Eugenol cements is known to interfere with the polymerization of resin-based permanent cements, potentially compromising the integrity of the final restoration (3). The absence of eugenol in non-eugenol cements eliminates this concern, making them a preferable choice for provisional restorations.

Clinical Implications

The clinical implications of these findings are significant. Minimizing marginal leakage in provisional restorations is crucial to prevent secondary caries, pulp irritation, and periodontal disease. The superior performance of resin-based cements suggests they should be preferred for cementing provisional crowns, especially in cases where a prolonged provisional phase is anticipated. This aligns with the recommendations of Federlin et al. (4), who emphasized the importance of selecting luting cements that ensure a reliable marginal seal to enhance the longevity of provisional restorations. (7-9)

Limitations and Future Directions

While the *in vitro* nature of this study allows for controlled comparison of different cements, it does not fully replicate the complex oral environment. Factors such as saliva, pH fluctuations, and masticatory forces can influence the performance of luting cements *in vivo*. Future studies should incorporate these variables to provide a more comprehensive assessment of marginal leakage.

Additionally, the use of only one type of provisional crown material (PMMA) may limit the generalizability of the findings. Different provisional materials may interact differently with various luting cements, influencing the extent of marginal leakage. Therefore, further research should explore the interaction between different provisional materials and temporary luting cements.

Conclusion

In conclusion, this study demonstrates that resin-based temporary luting cement significantly reduces marginal leakage of provisional crowns compared to Zinc Oxide Eugenol and Non-Eugenol Zinc Oxide cements. These findings highlight the importance of selecting appropriate luting agents to enhance the clinical success of provisional restorations. Future *in vivo* studies are warranted to validate these results and explore the impact of additional variables on marginal leakage.

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