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Evaluation of Marginal Micro-Leakage and Marginal Accuracy of Provisional Crowns Luted with Various Non-Eugenol Cements: An In-Vitro Study

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Keywords
Tempbond, micro-leakage, RelyXTempNE, Freegenol, mesiodistal

Abstract
Purpose: Assessment of marginal micro-leakage and marginal accuracy of non-eugenol temporary luting cements by the use of provisional crowns on prepared teeth.

Materials and Methods: 60 extracted mandibular molars of similar crown height were mounted in auto-polymerizing

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resin blocks. Tooth preparation to receive metal ceramic crown with shoulder finish line was done. The provisional crowns were fabricated using pre-operative putty index and were evaluated for marginal accuracy. Samples were divided into three groups with 20 samples in each. The crowns were cemented using Tempbond(Kerr U.K), RelyXTempNE (3M ESPE AG) and Freegenol (GC). Thermocycling was done for 250 times (5-60℃ temp.) with an interval of 10 s between two immersions. They were then immersed in 5% basic fuschin dye and sectioned. The marginal micro-leakage was assessed by observing the sectioned samples in between bucco-lingual and mesiodistal direction. Marginal accuracy was evaluated with stereomicroscope.

Results: Marginal microleakage and accuracy was highly significant with all the three cements and occurred between the tooth surface and the cement layer and not between the cement layer and the restoration.

Conclusion: Minimum marginal microleakage was obtained by RelyXTempNE and the highest marginal microleakage was founds in tempbond and Freegenol showed intermediate values.

1. Introduction

During creation of a fixed dental prosthesis, interim coverage of a prepared tooth and an edentulous area is crucial throughout the course of treatment . Success or failure of long-term repairs is now understood to be fundamentally influenced by the provisional repair. The interim restorations must be fixed with a temporary luting material that is both strong enough to hold the restoration in place and weak enough to permit the restoration's removal without endangering the abutment.

These divergent demands could result in cement washout, bacterial infiltration, cavities, and compromised cement behaviour, especially with regard to its mechanical qualities.[1] In many cases, temporary restorations in the oral cavity must operate well over time.

There are two ways to stop microleakage: by creating an interim restoration that fits perfectly, or by choosing the right temporary cements[2]. Due to their sedative and superior bactericidal properties, zinc oxide eugenol (ZOE) cements have long been the cement of choice for temporary restorations. Unfortunately, ZOE cements prevent polymerization of the methylmethacrylate resins used in temporary restorations by preventing free radical polymerization in the resins. Additionally, if the final restoration will be bonded to the prepared tooth, the polymerization of the adhesive system and the permanent resin cement may be slowed, increasing the risk of debonding or even fracture in the case of low-strength ceramic or indirect composite restorations.

Furthermore, some patients are hypersensitive to eugenol.[3,4] Many studies have investigated the sealing aptitude of both zinc oxide eugenol and zinc oxide non-eugenol temporary cements and concluded that these cements have poor sealing abilities.

Felton et al. reported that if the provisionalization period extends to more than 4 weeks, the incidence of pulpal necrosis will significantly increase, which indicates a high microleakage and bacterial penetration in provisional restorations.[2,5,6,7]

Recently, novel temporary cements with superior sealing properties have been developed employing various chemical bases. For instance, a recently introduced cement made of zinc polycarboxylate has the potential to chemically bind to the tooth structure through chelation. High strength, excellent retention, better aesthetics, minimal solubility, and simple cleanup are further characteristics of resin-based temporary cements. There are also silicone-based, addition-cured zinc oxide temporary cements with a silane ingredient for enhanced adhesion and mediocre integrity. Temporary cements' main purpose is to create a seal, stop marginal leakage, and so avoid pulp irritation. The "misfit" at different sites between restoration and tooth is the best way to describe the correctness of a restoration. [9] This study's objective is to assess the marginal micro-leakage and marginal accuracy of temporary crowns bonded to removed human teeth using various noneugenol ZnO-based temporary cements.

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2. Material and Methods

For orthodontic or periodontal reasons, sixty clinically sound molars were removed and preserved at 6°C in a 6.9 pH phosphate buffered saline solution. A comparative study was conducted using a total of 60 samples, separated into three groups, to assess the marginal micro-leakage and marginal accuracy of provisional bisacryl composite crowns cemented using three commercially available non-eugenol luting cements.

For the study, sixty mandibular molars that had been extracted were undamaged and free of caries were taken. The tooth root was added to acrylic resin using a 20 mm by 10 mm rectangular mould after any debris had been removed. Then, using polyvinyl siloxane substance with a putty-like consistency, a mould of the crown was created. The silicon material was placed into the mould after it was raised 20 mm above the resin level. This was done so that each tooth's cylindrical impression would have dimensions of 20 mm in height and diameter (Fig.1). For the purpose of preparing teeth for porcelain fused to metal (PFM) crowns, a flat and tapered diamond point was utilised (Fig.2).

Fig. 1 Putty index

Fig. 2 Prepared tooth sample

The bisacryl composite (protem) was injected into the putty impression before being manually applied to the corresponding tooth. An axial force of 5 kg was applied for 5 minutes with a wooden tablet leaning against the impression flat tops to maintain a steady pressure. The crowns were created in three batches of 20 pieces each. (Fig.3)

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Fig. 3 Protemp 4 crown

Each specimen preparation was cleaned, then dried with a cotton pellet after being stored in distilled water for 24 hours. The teeth with temporary fillings were separated into three groups of 20 samples each at random. As specified, a unique cement was given to each group.

The manufacturer's recommendations were followed when mixing the cements at room temperature of 23° ± 1°C, and the manufacturer's lowest recommended amount was used to apply the cement to the inner edge of the crowns in order to achieve a uniform distribution. A stereomicroscope was used to measure the marginal accuracy. Under a stereomicroscope, the mesial, distal, buccal, and lingual aspects of each side were examined (Fig 4).

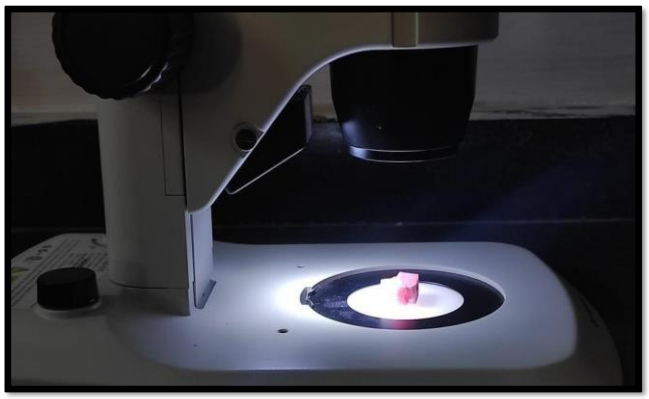

Fig. 4 Evaluation of marginal accuracy under microscope

An axial pressure of 10 kg was applied to the restorations for 10 minutes to cement them. In accordance with the parameters examined, the specimens were subjected to 250 thermal cycles by alternately immersing the teeth for 20 seconds at 5°C and then 50°C, with a 15-second gap between each immersion (Fig. 5). Following the thermocycles, the samples were once more submerged in distilled water at a temperature of 23°C (plus or minus one degree). To increase the dye's penetration, they were submerged in a basic fuchsin bath at 5% for an hour at a negative pressure of 27 mm Hg. he samples were then cut into sections in the buccolingual and mesiodistal directions using a circular, 1-mm thick, diamond-impregnated blade (Fig. 6).

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Fig.5 Thermocycling unit

In order to assess marginal microleakage, this sectioning produced 8 distinct measurement locations per specimen, which were examined using an optical microscope. One operator tracked the microleakage.

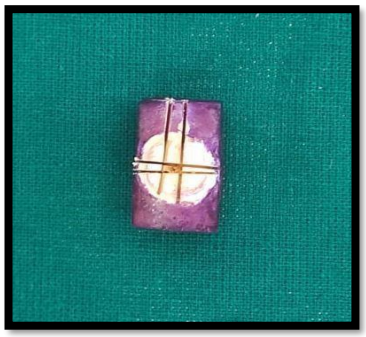

Fig. 6 Sectioning in mesio-distal

Fig. 7 Dye penetration & Bucco-lingual

Table 1. Score to evaluate the micro leakage

0	**no leakage**
1	leakage to 1/3rd of axial wall
2	leakage to 2/3rd of axial wall
3	leakage to more than 2/3rd of axial wall
4	leakage onto the occlusal surface

One-way ANOVA and post hoc Tukey testing were used to assess the intergroup marginal accuracy with various cements, while the Chi-square test was used to analyse statistical data for microleakage.

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3. Result

This study compared the marginal accuracy and microleakage in Bisacrylic composite crowns cemented with 3 different non eugenol cements. The results have been tabulated as under.

Table 2: Marginal discrepancy (µm) wise distribution among all the groups (Average) (one-way ANOVA)

Groups	Number	Marginal discrepancy (µm)		P Value
		Mean	SD	
(Group 1) Freegenol	5	58.00	4.60	0.000*
(Group 2) Temp bond	5	66.00	2.63	
(Group 3) 3M ESPE Rely X	5	43.00	4.63	

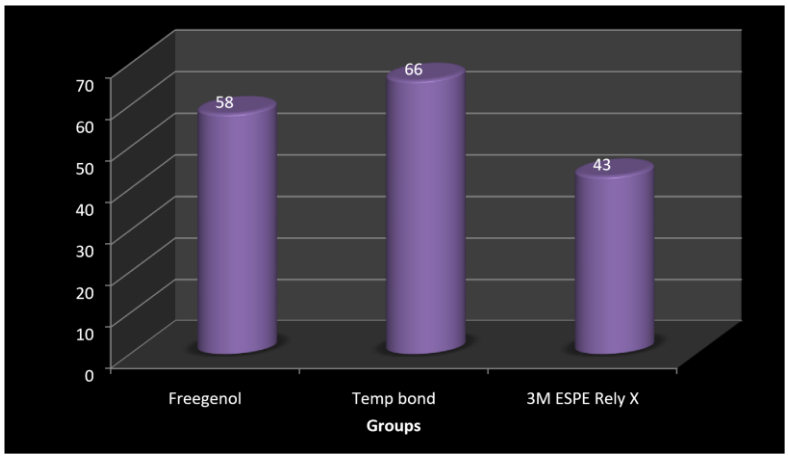
Level of Significance P ≤ 0.05, * Significant, ** Non-Significant

SD- standard of deviation, um-Micrometer

The Temp bond group had the highest marginal difference (66.00 ± 2.63 µm) followed by

Freegenol group (58.00 ± 4.60 µm) and 3M ESPE Rely X group (43.00 ± 4.63 µm) respectively.

There were statistically significant differences between the different groups.



Graph 1: Marginal discrepancy (µm) wise distribution among all the group

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Table 3: Pair wise Comparison (Average) (post hoc tukey)

Groups		Difference	P Value
(Group 1) Freegenol	(Group2) Temp bond	-8.00	0.023*
	(Group 3) 3M ESPE Rely X	15.00	0.000*
(Group 2) Temp bond	(Group 3) 3M ESPE Rely X	23.00	0.000*

Level of Significance P ≤ 0.05, * Significant, ** Non-Significant Statistically, significant difference was present among all groups.

Table 4: Micro leakage wise distribution among all groups (chi square test)

Score	Groups N (%)			Total N (%)
	Freegenol	Temp bond	3M ESPE Rely X	
0 (No leakage)	7 (35%)	4 (20%)	13 (65%)	24 (40%)
1 (Leakage to 1/3 of axial wall)	13 (65%)	13 (65%)	7 (35%)	33 (55%)
2 (Leakage to 2/3 of axial wall)	0 (0%)	3 (15%)	0 (0%)	3 (5%)
3 (Leakage along the full length of axial wall)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
4 (Leakage cover the occlusal surface)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	20	20	20	60
P Value = 0.009*				

Level of Significance P ≤ 0.05, * Significant, ** Non-Significant

Majority of the study subjects were having Micro leakage score 1 in Freegenol group (65%) and Temp bond group (65%) while in 3M ESPE Rely X group, majority of the study subjects (65%) were having Micro leakage score 0. Statistically, significant difference was present among various groups in micro leakage.

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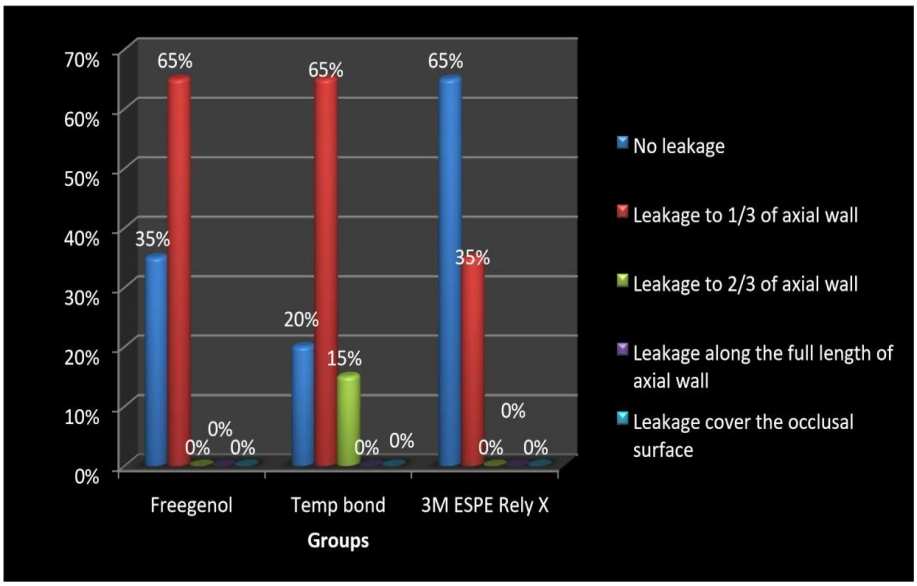

Graph 2: Micro leakage wise distribution among all groups

4. Discussion

The goal of the study was to compare the marginal micro leakage and marginal accuracy of temporary crowns glued with three different non-eugenol luting cements. On 60 samples of surgically removed human mandibular molars, we tested Freegenol (GC Corp, Toyo Japan), Temp bond (Kerr, U.K.), and 3M ESPE Rely X temp NE (Super bite, Bosworth Company, Skokie).

The flow of microorganisms, fluids, chemicals, or ions along the tooth-restoration contact is referred to as micro leakage. Even though this leakage may not be visible to the naked eye, it has a substantial biological impact on the repaired tooth, leading to hypersensitivity, pulpal pathology, recurrent caries, discoloration, and marginal disintegration. [8]

Freegenol The features of the cement utilised to cementing crowns that enable close interaction between prepared teeth's surfaces and restorations must be careful. highlighted among the many factors that determine the quality of retention and marginal seal.

Micro leakage and a loss of bonding effect have been linked to cement breaking down through its dissolution in oral fluids, shrinkage during setting, and strength and deterioration of the binding between cement and dentin or cement and restoration. The dimensional variations of materials used for temporary crowns brought on by mechanical stress, thermal contraction, water absorption, and polymerization shrinkage are also related to micro leaks. The contraction pressures produced by a resin's polymerization shrinkage could damage the binding within the cavity walls, resulting in marginal failure and eventual microleakage. When examining a dental restorative material's performance, the integrity and toughness of the marginal seal have always been of utmost importance. [9,10]

Young et al. also advised against using eugenol-containing cements extensively in clinical settings because of the high film thickness that leads to greater water absorption, which reduces mechanical properties and ultimately causes microleakage, which is consistent with the findings of the current study. [10] The two main factors that contribute to the failure of fixed restorations are microleakage and marginal opening. Tempo SIL, RelyX Temp NE, and Freegenol, three zinc-oxide-based non-eugenol temporary luting agents, were tested utilising temporary crowns on the dentinal surface of recently extracted human premolars in this in vitro investigation. For Tempo SIL (A), RelyX Temp NE (B), and Freegenol (C), the mean values for buccal microleakage were 1043.25±294.44, 3651.43±1299.86 and 2008.96±273.36,

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respectively. In contrast to the findings of the current investigation, the mean values for lingual microleakage for Tempo SIL (A), RelyX Temp NE (B), and Freegenol (C) were 1169.35±386.08, 3782.49± 1180.50 and 2047.51±347.51, respectively. The sluggish process of cement disintegration, which most likely occurs later, is accelerated by cement microfractures. Therefore, the focus of this investigation was on cement adherence to the tooth rather than the effects of cement breakdown.[11-15]

Dental resins suffer from eugenol cements because the eugenol that remains after the cement has dried out acts as a plasticizer and softens the resin. As a result, a variety of enhanced eugenol-free cements that comprise polyorganic acid, polycarboxylate, etc. have been introduced. These cements have the benefits of having a thin coating and not interfering with final cementation. They exhibit higher retention compared to ZOE cements and properties of being suitable for resin temporary materials and resin cements. Microleakage was found least with HY bond, which have polycarboxylate, it aids in reducing microleakage and strengthens the marginal seal and has high bonding strength for provisional restorations, of the two eugenol-free cements (RelyXtempNE and HY bond). [16-18]

Similar significant results were achieved in the current investigation. S.J. Arora reported that marginal leakage was significant in provisional crowns bonded with three different luting cements along the axial walls of teeth. TempoSIL's cement layer was visible as a strip of opaque whiteness. Other two cements, RelyXTempNE and Freegenol, however, had minor fissures visible in the cement layer. The composition can be used to explain the variation in cement layers. Polymethylsiloxane with zinc oxide is TempoSIL. In the zinc oxide cements RelyXTempNE and Freegenol, different mineral oils are used in place of eugenol. [19]

It was noted that the comparative assessment of the marginal micro leakage of Freegenol was similar to the current in vitro study. The clinical setting is simulated utilising Tempbond, 3M ESPE, and removed teeth and thermocycling. Additional research is necessary to assess the clinical relationship between marginal micro-leakage and marginal accuracy of temporary luting cements used on provisional crowns.

5. Conclusion

- ✓ Minimum marginal microleakage was obtained by RelyX Temp NE and the highest marginal microleakage showed in tempbond and Freegenol showed intermediate values. So the marginal microleakage is in following order Tempbond > Freegenol > 3M ESPE
- ✓ Highest marginal discrepancy seen in Freegenol followed by tempbond and 3M ESPE. Marginal discrepancy is in following order Freegenol > Tempbond > 3M ESPE

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