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Editorial Office
Dr. (Mrs) S. J. Nagda
Prof. & Head,
Dept. of Prosthodontics,
Nair Hospital Dental College,
Mumbai - 400 008, India.
E-mail: jipseditor@yahoo.co.in

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IPS Office
Dr. V. Rangarajan
Hon. Gen. Secretary cum Treasurer, 230, Avvai Shanmugham Salai,
Royapettah, Chennai - 600014, India. E-mail: drvranga@gmail.com

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CONTENTS

Original Article

Evaluation of marginal microleakage of three zinc-oxide-based non-eugenol temporary luting agents: An *in vitro* study

Subhash Bandgar, S. J. Nagda
Department of Prosthodontics, Nair Hospital Dental College, Mumbai, Maharashatra, India

For correspondence
Dr. Subhash Bandgar, Department of Prosthodontics, Nair Hospital Dental College, Mumbai Central, Mumbai, Maharashatra, India.
E-mail: subhashpro@gmail.com

AIM: The marginal microleakage of recently used non-eugenol temporary cements is not well documented. **PURPOSE:** To evaluate the marginal microleakage of three zinc-oxide-based non-eugenol temporary luting agents using temporary crowns on prepared natural teeth. **MATERIALS AND METHODS:** Freshly extracted 90 maxillary premolars of approximately similar crown height (7.8 mm–8.3 mm) were embedded in cold-cure resin blocks. Standard tooth reduction for ceramometal restorations with shoulder margin was planned using a customized handpiece-holding jig. Temporary crowns were prepared using the putty index technique following the tooth preparation. Specimens ware randomly divided into three groups of 30 each and temporary crowns were cemented using TempoSIL (Coltene/Whaledent AG), RelyXTempNE (3M ESPE AG), Freegenol (GC).The specimens were thermocycled for 250 times in the range of 5–60 degree with an interval of 10 s between two immersions. All the specimens were immersed in 5% basic fuschin and then embedded in cold cure resin and sectioned. The sectioned specimens were observed on the buccal and lingual side under optical microscope with an image analyzer for the evaluation of marginal microleakage. **RESULTS:** Marginal microleakage was highly significant in 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 with the application of Templute. RelyXTempNE had the highest marginal microleakage and Freegenol showed intermediate values.

Key words: Freegenol (GC), marginal microleakage, RelyXTempNE (3M ESPE AG), Temposil (Coltene/Whaledent AG)

INTRODUCTION

A temporary luting agent that is used to fix the interim restorations must be strong enough to retain the restoration; however, at the same time, it should be weak enough to enable the removal of the restoration without damage to the abutment.[1] Retention and marginal leakage are the two important parameters that may affect the success of a long-standing provisional crown. The clinical situations may dictate the need for a long-term provisional restoration in accordance with the stomatognathic dynamics of the patient.[2]

The temporary restorations act as a blue print for the final treatment outcome. Provisional cemented for a long duration are susceptible to cement washout, bacterial infiltration and caries. Chemical and thermal insults, even for a short duration, are sufficient to damage the vital pulp in the remaining tooth structure.[3] All these complications start with an incomplete marginal seal. As marginal microleakage is the initiation of a break in marginal seal, it is prudent to have temporary cement that provides a good marginal seal and protects the remaining tooth structure and pulp.

An *in vitro* study was designed and carried out to compare the marginal microleakages of three temporary luting agents – TempoSIL, RelyXTempNE and Freegenol – using temporary crowns.

MATERIALS AND METHODS

Freshly extracted 90 maxillary premolars of approximately similar crown height (7.8 mm–8.3 mm) were selected and mounted on an acrylic block using cold-cured resin. A custom aluminum jig was used to hold the hand piece with the vertical arm of surveyor and orient the bur in a perpendicular position to obtain the standard preparation of all the specimens [Figure 1]. The teeth were prepared for metal ceramic crown with shoulder margin with 6-degree taper (leeway of 2 degree). Temporary crowns were made using the indirect technique with Tempron (GC). Before cementation, all the samples were examined

under a magnifying glass for marginal ; using Nikon measurescope, the marginal discrepancy of all the specimens is found [Figure 2]. Samples showing marginal discrepancy more than 50 µ were discarded. The specimens were randomly divided into three groups. The cementation of the temporary crowns was performed as per the manufacturer's instructions under a load of 5 kg applied for 5 min during the cementation process.

After cementation, samples were kept in distilled water for 4 days. To simulate the thermal insults to which the prosthesis is exposed in the oral cavity, thermocycling was performed using a customized protocol. All the specimens were thermocycled using two baths. The temperature of one bath was kept at 5° (± 2°) C using salt, ice and water. The temperature of the other water bath was electrically maintained in the range of 60° (± 2°) C. The specimens were immersed for 20 s in each baths: first in the 5°C bath and then in the 60°C bath with an interval of 10 s between two immersions. With this protocol, 250 cycles were completed for each sample. All the specimens were then immersed in bath of 5% basic fuschin for 1 h. After this, all the markings of the specimens were done on the acrylic block with reference to the height of contour on both the buccal and lingual sides. The specimens were embedded in polymethylmethacrylate (pink color) resin using an aluminum jig. Specimens were sectioned in the buccolingual direction using a surface grinder [Figure 3]. At predetermined locations, all the specimens under the optical microscope were viewed from margin of the prepared tooth till the point of dye penetration on the buccal and lingual sides for microleakage and to the highest point of tooth preparation for the tooth length.

The data obtained was tabulated and subjected to statistical evaluation.

RESULTS

The specimens were examined using an optical microscope for dye penetration and the prepared tooth length. The mean values for buccal microleakage for TempoSIL (A), RelyXTempNE (B) and Freegenol (C) were 1043.25±294.44, 3651.43±1299.86 and 2008.96±273.36, respectively. The mean values for lingual microleakage for TempoSIL (A), RelyXTempNE (B) and Freegenol(C) were 1169.35±386.08, 3782.49± 1180.50 and 2047.51±347.51, respectively.

The results were statistically analyzed by Scheffe's test**.** The statistical analysis showed that the values for microleakages were statistically significant on both the buccal and lingual sides [Table 1] and not significant for the tooth length [Table 2].

The observation under the optical microscope with 50X magnification showed that the microleakage of basic fuschin dye was between the cement layer and the tooth surface. No microleakage was observed between the crown and the cement. The cement layer in group of TempoSIL [Figure 4] appeared as an opaque white band. However, in RelyXTempNE [Figure 5] and Freegenol some cracks were observed in the cement layer.

DISCUSSION

Microleakage and marginal opening are the important causes for fixed restoration failures.[4] In this *in-vitro* study, marginal microleakages of three zinc-oxide-based non-eugenol temporary luting agents – TempoSIL, RelyXTempNE and Freegenol – were compared using temporary crowns on the dentinal surface of freshly

Table 1: Scheffe's test for the comparison of the buccal and lingual microleakages between the groups

Microleakage	Group (I)	Group (II)	Mean difference (I – II)	Standard error	Significance
Buccal microleakage	A	B	2608.18	202.82	0.000*
	A	C	965.71	202.82	0.000*
	B	C	1642.47	202.82	0.000*
Lingual microleakage	A	B	2613.14	192.26	0.000*
	A	C	878.16	192.26	0.000*
	B	C	1734.98	192.26	0.000*

(*Difference is highly significant at $P < 0.001$)

Table 2: Scheffe's test for comparison of the buccal and lingual tooth length between the groups

Tooth length	Group (I)	Group (II)	Mean difference (I – II)	Standard error	Significance
Buccal tooth length	A	B	16.54	36.66	0.903*
	A	C	14.96	36.66	0.920*
	B	C	1.58	36.66	0.999*
Lingual tooth length	A	B	55.61	60.55	0.657*
	A	C	62.84	60.55	0.585*
	B	C	118.46	60.55	0.154*

(Difference is not significant $P > 0.05$)

Figure 1: Tooth preparation

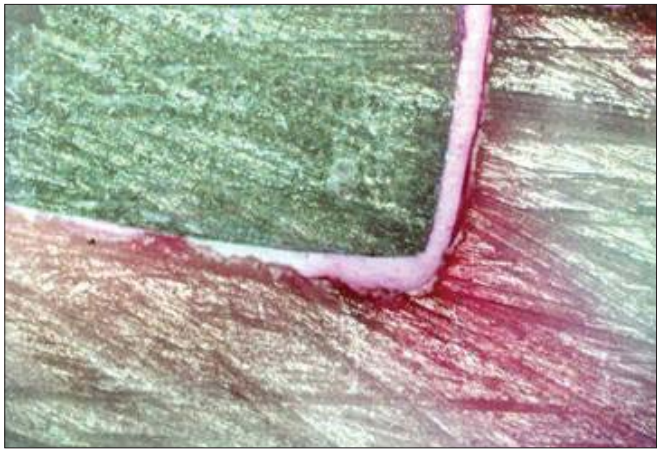

Figure 4: Microleakage of specimen observed under optical microscope at 50x magnification (TempoSIL)

Figure 2: Measuring marginal discrepancy using Nikon measurescope

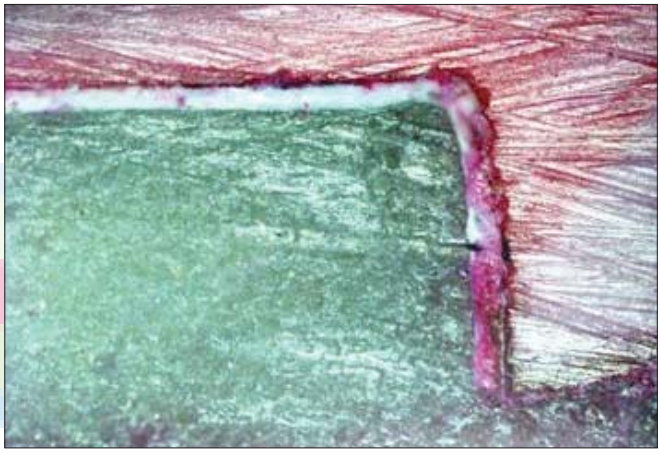

Figure 5: Microleakage of specimen observed under optical microscope at 50x magnification (RelyXTempNE)

Figure 3: Sectioned specimen

extracted human premolars. Cement dissolution is a slow process and probably takes place later and it is enhanced by cement microfractures. Therefore, this study mainly examined the adhesion of the cement to the tooth rather than the consequences of cement dissolution.

A total of 90 maxillary premolars of average size, extracted for orthodontic reasons, were used in this study to avoid the age bias. Tooth preparation was done with shoulder finish line using a surveyor and handpiece holder to keep the angle of preparation and reduction uniform for all the teeth, i.e., 6 ± 2 degrees with a shoulder finish line as it has smaller gap width as compared with the chamfer finish line.[5] Crowns were made with the indirect technique of temporization since it has a more accurate fit, as studied by Crispin *et al.*[6] and Mondey *et al.*[7]

One of the physical properties of the acrylic resin considered to be of serious consequence is their

high coefficient of linear expansion of acrylic resin as compared with the tooth.[8] Due to this difference in coefficients; the thermal expansion of the resin is greater than the tooth structure.[9,10]

At present, there is no uniform thermocycling design and the degree of tracer penetration is independent of the dwell time and there was no significant difference in microleakage with the thermocycling systems.[11] The thermocycling designs used vary in number of cycles, dwell time and the extreme temperature. In general, most of them have a temperature range of 0°C- 60°C.[1,2,12-14] In the present study, a temperature range of 5°C - 60°C with a dwell time of 10 s and 250 cycles were used as an excessive numbers of cycles are not required.[15]

Dyes permit the direct observation of the total marginal interface during evaluation and the scoring of marginal leakage are nontoxic and permit clinical as well as laboratory investigation. A solution of basic fuchsin dye was used to access the microleakage in this study. Basic fuchsin has been used extensively in the past to evaluate microleakage.[16-19]

The marginal microleakage was assessed using an optical microscope with x50 magnification. The optical microscope used in the present study had a resolving power of 0.01 µ permitting the qualitative evaluation of the tooth-cement interface.

In the present study, the microleakage observed in all the tested provisional cements was between the biologic tissue and the cement. The observations of this study are similar to the findings of the study carried out by Baldissara *et al.*,[2] but in contrast with the studies of Lewinstein *et al.*[14] They observed that the dye penetrated along both the sides of the luting agent Freegenol, this was to present study. However, with Tempbond and Duraphat, the dye penetration occurred at the interface between the tooth surface and luting agent, and this observation was similar to that of the present study. As in study carried by Lewinstein *et al.*[1] The marginal microleakage was evaluated on the decemented crown, and the interface was not evaluated.

In this study, microleakage was the least with TempoSIL and highest with RelyXTempNE and intermittent with Freegenol. The statistically significant results obtained when comparing the experimental specimens confirm that the microleakages obtained with the three materials were due to the difference in cementation material itself and not due to any prior intervention or experimental errors.

Previous studies on non-eugenol temporary cements had varied findings. In the study of marginal microleakage by Lewinstein *et al.*,[14] the marginal microleakage of Tempbond, Freegenol and Durafat were studied using the extracted molars. They observed that Durafat exhibited the least marginal leakage. Tempbond had a lesser marginal leakage value than Freegenol. Lewinstein *et al.*[1] studied the marginal microleakage on extracted molars using Tempbond, TempbondNE and Freegenol and stannous fluoride was added in these luting agents. They observed that Freegenol had the least dye penetration amongst all, which was contrary to that of the previous study.

The cement layer of TempoSIL appeared as an opaque white band. However, the cement layer of other two cements (RelyXTempNE and Freegenol) showed some cracks. The difference in the cement layers can be explained on the basis of composition. TempoSIL is polymethylsiloxane with zinc oxide. RelyXTempNE and Freegenol are zinc oxide cements in which eugenol is replaced by other mineral oils. As silicone is a major constituent of TempoSIL, it is a resilient material and it can withstand thermal stresses better than RelyXTempNE and Freegenol.

In vitro microleakage tests carried out with dyes are considered to be stricter than in the oral cavity[20,21] because (1) the dye is more easily diffused in the space of leakage in the extracted teeth than bacteria and their byproducts in the oral cavity, (2) the buildup of proteins and debris can improve the seal in oral cavity and (3) in oral cavity, the dentinal fluid of the vital teeth has a positive pressure and the fibrinogen settling inside the sectioned tubules may resist molecular penetration. On this basis, if any material responds positively to the dye test, it is likely to respond even better on a clinical level.

In this *in vitro* study, the comparative evaluation of the marginal microleakage of TempoSIL, RelyXTempNE and Freegenol using extracted teeth and thermocycling is performed to simulate the clinical situation. Further studies are required to evaluate the clinical correlation of the results of the present *in vitro* study.

CONCLUSION

Within the limitations of the study, the following conclusions were drawn:

1. Minimum marginal microleakage was observed with the application of TempoSIL. RelyXTempNE had highest marginal microleakage and Freegenol showed intermediate values.
2. Differences in values of marginal leakage in all three cements were statistically significant ($P < 0.001$).
3. Although natural teeth were used for study, the variation in the tooth length between the groups of the teeth was not significant statistically ($P > 0.05$).
4. Under optical microscope, it was observed that the microleakage of basic fuchsin dye was between the cement layer and the tooth surface. No

microleakage was observed between the crown and the cement.

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