



## MICROLEAKAGE OF TEMPORARY CROWNS WITH DIFFERENT CEMENT GAP

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### ABSTRACT

**Objective:** To evaluate the effect of different cement gap on microleakage of PMMA crowns cemented with resin cement. **Materials and Methods:** Thirty natural human molar teeth were collected, the root of the teeth was sealed with a double layer of varnish for insulation to a level of 1 mm below the preparation margin, and mounted in an acrylic mold. Teeth were prepared through CNC, PMMA crowns fabricated by CAD/CAM. Samples were divided into 3 subgroups according to the cement gap (CG) (n=10): 25 $\mu$ m (CG25), 50 $\mu$ m (CG50), 100 $\mu$ m (CG100). PMMA crowns cemented with Breeze Self-Adhesive Resin Cement. Samples were thermocycled for 5000 cycles between two water baths at 5°C and 55°C with a dwell time of 20 seconds and 10 seconds of transfer time. Samples were immersed in methylene blue dye solution for 24 hours, then sectioned buccolingually. Dye penetration was assessed using a spectromicroscope, and then a score assessment was done for the microleakage. **Results:** The CG50 group scored the lowest median microleakage score, followed by CG100, and finally, CG25. The CG25 group; showed a statistically significantly higher median microleakage score than CG50 or CG100 groups. **Conclusion:** The cement gap has an effect on the microleakage of PMMA crowns cemented with self-adhesive resin cement.

**KEYWORDS:** Cement gap, Microleakage, PMMA, Resin cement

### INTRODUCTION

The long-term success of restorations depends on cement properties such as cement type, physical and mechanical properties of the luting agent, placement techniques, seating force and environmental conditions<sup>(1)</sup>.

Dental luting agents act as a link between the supported tooth prepared and the FDPs. Cements have developed steadily over the past decades. Resin cements have the property to adhere to both the internal surface of the restoration and the tooth structure. The adhesion mechanism of earlier resin cements was mostly micromechanical, but newer

cements, especially those containing self-etch primers and acidic monomers, have been shown to bond chemically to the tooth structure and restoration as well<sup>(2)</sup>.

Because of their high bond strengths to the tooth structure, the resin cements provide more retention than conventional luting cements. However, they require multiple steps, are challenging to clean up, and are more technique sensitive than conventional cements<sup>(2)</sup>.

Self-adhesive resin cements have been developed in an attempt to decrease bonding steps and improve ease of use. This approach combines the

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adhesive and the cement in one step. Examples include Breeze self-adhesive resin cement. Clinicians may choose these cements because of their simplicity and, therefore, their reduced potential for application errors<sup>(3)</sup>.

Long-term temporization for more than six months made from semi-definite materials may be needed in some cases. As stated by the German Society of Dental, Oral and Craniomandibular Sciences (DGZMK)<sup>(4)</sup>, such long-term temporaries are indicated for treatment including changes of vertical dimension, aesthetics or phonetics, for palliative prosthodontic treatment in cancer patients and for bridging the time of healing or exploring potential abutment teeth with unclear prognosis for definitive restorative treatment later in time. All these objectives may need temporaries for about one year and or even longer time.

Microleakage, which enables the infiltration of micro-organisms, liquid, and chemical substances from the oral environment along with the tooth/restoration interface, is one of the most critical issues to test the luting cement. This can lead to the accumulation of bacteria, causing postoperative pain, recurrent caries, or pulp damage, which are the most common reasons for failure to recover<sup>(5,6)</sup>.

Cement gap, also known as die spacer, is an essential factor in microleakage prevention, it helps to reduce the resistance to flow of cementing material, enabling full restore seating and providing an excellent marginal seal. The flow resistance of cementing materials may result in the crown's incomplete seat that may generate marginal inconsistencies and subsequent microleakage<sup>(7)</sup>.

An essential cause of a microleakage is the thermal fluctuation occurring in the oral cavity. The hot and cold temperatures are stressed cyclically by changes in the thermal expansion factor of the tooth and the combing cement at the tooth cement interface. These stress-induced were resisted only from binding strength and could lead to a micro

gap with a low bond strength on the tooth cement interface<sup>(8)</sup>.

Although the importance of clinical studies and their realistic results may be retained and scaled by in vitro evaluation, the bioactive combinable cement may be considered sensitively. Aim of this study was to evaluate the effect of different cement gap on microleakage of PMMA crowns cemented with resin cement. Hypothesis was the smallest cement gap will perform better against microleakage.

## MATERIALS AND METHODS

Thirty natural human molar teeth were freshly extracted due to periodontal problems, examined under the magnifying lens to be clear of any defects, caries, or cracks, then washed, preserved for two weeks in 0.1% chloramine solution and then at room temperature in distilled water.

The root surfaces of the teeth were sealed with a double layer of varnish for insulation to a level of 1 mm below the preparation margin. Polyvinyl chloride (PVC) cylinder of 2.5 cm diameter was cut into an equal length of 2 cm to be used as a mold. A centralizing device was used to standardize the mounting of each tooth in a vertical direction within the mold to allow accurate centralization of the teeth within the acrylic mold.

A computer numerical control (CNC) (CNC Premium 4820-i-mes, Germany) unit was used to standardize teeth preparation to receive a full-coverage crown<sup>(9)</sup>. The Preparation design was round shoulder finish line with thickness 1 mm, flat occlusal surface, 20° total convergence, and 4 mm high.

Temporary crowns were fabricated from Polymethyl methacrylate (PMMA) (Yamahachi PMMA Disk; Yamahachi Dental Mfg Co, Gamagori, Japan), using CAD/CAM, (Roland dwx 52D, Roland, Hamamatsu, Japan).

Samples were divided randomly into three subgroups according to the cement gap setting of the CAD/CAM (n=10)

- a. Cement gap 25 $\mu$ m (CG25)
- b. Cement gap 50 $\mu$ m (CG50)
- c. Cement gap 100 $\mu$ m (CG100)

PMMA crowns were cemented on prepared teeth using Breeze Self-Adhesive Resin Cement (Pentron Clinical Technologies, Wallingford, Ct, USA), which is an automix dual-cure self-adhesive resin cement.

Adhesive cement was used according to manufacturer's instruction, and a static load of 50 N placed over the samples for 5 minutes using a specially designed loading device<sup>(10)</sup>, excess cement was removed after initial setting by using explorer. After complete setting and polymerization of the luting cements, samples were placed in distilled water for 24 hours to allow the relief of internal stresses of the cement.

All samples underwent thermocycling for 5000 cycles which simulated 6 month of service in the oral cavity<sup>(11)</sup> between two water baths at 5°C and 55°C with a dwell time of 20 seconds in each bath and 10 seconds of transfer time between the two baths.

Samples were immersed in methylene blue dye solution (Loba Chemie, Mumbai, India) for 24 hours in an incubator at 37°C<sup>(12)</sup>, then washed out with running tap water to remove the residual dye. Samples were sectioned buccolingual using a diamond wheel (Isomet 5000, Buehler, USA).

Dye penetration was assessed using a spectromicroscope (Nikon MA 100, Japan) with 50 X magnification. Image analysis was performed using computer software Omnimet (Buehler, USA) and recorded in micrometer ( $\mu$ m).

A score assessment was recorded, according to Tjan et al.<sup>(13)</sup> where : 0 = absence of dye penetration; 1=microleakage to one-third of the axial wall; 2=microleakage to two-thirds of the axial wall; 3=microleakage along the full length of the axial wall; 4=microleakage over the occlusal surface.

Collected data was tabulated, and statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0 (Armonk, NY: IBM Corp.).

## RESULTS

Ordinal data were represented by mean and standard deviation (SD) values, and they were analyzed using the Kruskal Wallis test followed by multiple pairwise comparisons utilizing Dunn's post hoc test. The significance level was set at  $p \leq 0.05$ .

There was a significant difference between the microleakage scores in samples with different gap distances ( $p < 0.001$ ). The highest microleakage scores were found CG25 (2.36 $\pm$ 0.21) followed by CG100 (1.75 $\pm$ 0.14) while the lowest scores with found in samples with CG50 (1.66 $\pm$ 0.20).

Pairwise comparisons showed CG 25 to have a significantly higher microleakage score than samples with other gap distances ( $p < 0.001$ ).

**TABLE (1)** Mean  $\pm$  standard deviation (SD) of microleakage scores for different cement gap.

Cement type	Cement gap (mean $\pm$ SD)			p-value
	CG25	CG50	CG100	
Resin (PRC)	2.36 $\pm$ 0.21 <sup>A</sup>	1.66 $\pm$ 0.20 <sup>B</sup>	1.75 $\pm$ 0.14 <sup>B</sup>	<0.001*

*Different superscript letters indicate a statistically significant difference within the same horizontal row\*; significant ( $p \leq 0.05$ ) ns; non-significant ( $p > 0.05$ )*

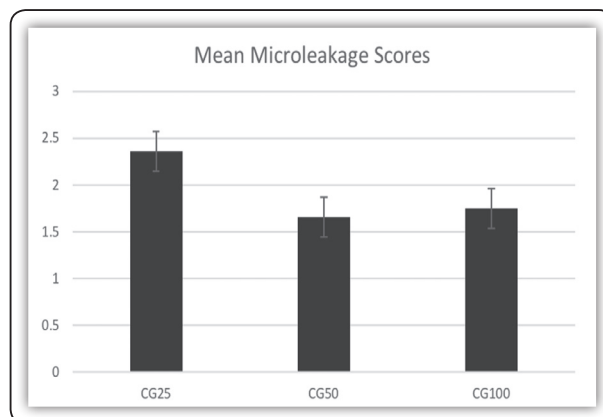


FIG (1) Bar chart showing mean microleakage scores for different cement gaps. CG=Cement Gap

## DISCUSSION

Dental luting cements play a vital role in the success of indirect restorations. The primary function of the luting cement is to fill the gap between the prepared tooth and indirect restoration, in addition to mechanically or chemically bonding the restoration to the preparation to prevent dislodgement during the function. A final property is to enhance the color of the esthetic all-ceramic restoration<sup>(14-16)</sup>.

Resin cements have gained popularity in the dental market during recent years due to high compressive and tensile strengths, low solubility, and favorable esthetic qualities. In addition, *in vitro*, and *in vivo* studies suggest that resin bonding helps diffuse stress and limit crack propagation on the internal aspect of porcelain restorations<sup>(17)</sup>. However, they are expensive and have the disadvantages of being technique sensitive, easily contaminated during multiple-step application procedures, and difficult and time-consuming during clean-up<sup>(18)</sup>.

Microleakage test using dye was also performed to assess the effectiveness of the sealing ability of bioactive cement to prevent or decrease the microleakage underneath the prosthesis.

Numerous methods and techniques have been utilized to investigate microleakage, cross-sectional view, direct view, air pressure, fluid filtration, electrochemical, and radioisotope methods, with the dye penetration technique being the most popular method<sup>(19)</sup>. This method gained its popularity because of its feasibility and simplicity and was used in the current study.

Various tracers have been used (such as basic fuchsin, eosin, methylene blue, and silver nitrate). One study reported that basic fuchsin was used most often in previous studies (40.7%) followed by methylene blue (22%) and silver nitrate (17%)<sup>(20)</sup>. In this study, the teeth were immersed in 2% methylene blue dye solution for 24 h.

The sealing ability of any cement is affected by mechanical, physical, and chemical properties of that cement, which depend mainly on its chemical composition. In general, cements with desirable mechanical properties, dimensional stability, excellent adhesion to the tooth structure, low film thickness, low solubility in oral fluids, and a similar coefficient of thermal expansion to the coronal tooth structure typically possess excellent sealing abilities<sup>(21)</sup>.

The CG50 group scored the lowest median microleakage score, followed by CG100, and finally CG25, (1.66±0.20), (1.75±0.14), and (2.36±0.2).

The results revealed that either CG50 or CG100 groups, there was no statistically significant difference between the median microleakage scores. However, the CG25 group; showed a statistically significantly higher median microleakage score than CG50 or CG100 groups.

The CG25 group scored the highest microleakage score, and this may be attributed to incomplete seating of the crown or due to increased cement film thickness.

On the opposite side, CG50 scored the lowest microleakage score, which may be caused by a better seating of the crown and better margin seal which decrease microleakage, as Kale et al. found that increasing cement space decreased the marginal discrepancy<sup>(22)</sup>.

The high number of thermocycling (5000 cycles), which simulate six months of service in the oral cavity<sup>(11)</sup>, may have caused some dimensional changes in the PMMA. Moreover, this may have affected the bond between the cement and the PMMA surface. Moreover, the adhesion of both cement with the Pmma is not known

## CONCLUSION

Within the limitation of this study, it was concluded that cement space affects the microleakage of PMMA crowns cemented with self-adhesive resin cement.

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