Invitro Evaluation Of Marginal Integrity And Microleakage Of Ceramic Crowns Luted With Different Adhesive Cements- A Stereomicroscopic Study

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ABSTRACT:

Aim: Aim of the current research was to assess the marginal integrity as well as microleakage of ceramic crowns luted with different adhesive cements by using stereomicroscope.

Materials and Methods: 60 healthy premolar teeth that were subjected to extraction for the purpose of orthodontic treatment were included for this research. A calibrated and trained researcher performed single crown restoration preparation following which the crowns were made. The 60 specimens were randomly assigned to one of the following three groups (20 premolar samples each), with every group employing a different luting cement. Group A: A dual cure resin cement, Group B: Glass ionomer luting cement, Group C: Self cure resin cement. Each premolar sample was subjected to thermocycling at 5°C ± 2°C along with 55°C ± 2°C for five hundred cycles. Each sample that had been painted was immersed in 1% methylene blue solution for 24 hours to allow dye-diffusion within any likely spaces amid the crown and the tooth. A sagittal cross-section of each specimen was done and the sectioned teeth were scrutinized below stereomicroscope at 10× magnification by means of image analysis software. Evidence of a blue-color response on the tooth-cement edge substantiated microleakage.

Results: Least microleakage was depicted by dual cure resin cement group (1.12 ± 0.09), trailed by Self cure resin cement group (1.36± 0.16) and then the GIC luting group (2.80± 0.02). The analysis of variance showed statistically significant differences amid the different luting cements. On multiple comparisons amid the luting cements, the difference between Group A and Group B, Group B and Group C luting cements (p<0.05) was statistically significant, while the difference amid Group A and Group C (p>0.05) was not significant statistically.

Conclusion: Considering the limitations of this research, a conclusion that dual cure resin cement group reveal appreciably lesser microleakage compared to self cure resin cement group and glass ionomer luting cement group.

Keywords: Luting materials, methylene blue dye, microleakage, thermocycling

INTRODUCTION:

The essence of fixed prosthetic rehabilitation is replacing teeth with artificial alternatives that are not easily detachable from the oral cavity. The final outcome of any form of prosthodontic therapy is to offer the patient, a meticulously designed restoration that conserves the longevity and pulp vitality of natural teeth used as abutments to fixed prosthesis. In order to achieve this it is essential that cements used for luting have amply less viscosity to flow at the interface of the fixed prosthesis and hard tissue. Additionally, luting cements should have the capacity to wet either surface so that the prosthesis is held in place. Considering the physical/biological characters and handling properties such as working/setting time, consistency and simplicity of eliminating the surplus material is significant to achieve the best possible performance.¹

Luting cements used in dental practice are an important connection amid the tooth that has been prepared and the prosthesis, attaching them via an attachment type, that could be chemical, mechanical/micro-mechanical or a mixture of any. Such a bond is significant to avoid pulp insult as well as microleakage, in addition to causing a
mechanical locking of the prosthesis in position without its displacement during chewing food.\(^2\)

Luting products of various kinds are obtainable and picking a particular type is influenced by numerous factors. Enhanced retention power of the prepared abutment is dictated by factors such as its geometric design, decreased angle of convergence, greater axial surface and nominal occlusal surface reduction.\(^3\)

Glass ionomer cements (GIC) offer a multitude of clinical benefits. These comprise physico-chemical attachment to teeth, fluoride discharge and less thermal expansion coefficient. The binding of GIC is a result of bond creation linking the carboxyl groups of polyacrylic acid and hydroxyapatite at surface of the teeth.\(^4\)

Dual-cure resin cements can be cured by use of both light as well as chemicals. Despite this, dual-cure resin cements need light-curing to attain a soaring amount of polymerization. They are hence frequently employed in metal-free restorations where use of light for curing may be readily executed to seal margins.\(^5\) Self-cure resin cement consist multifunctional phosphoric acid methacrylates which are well known for their interaction with hydroxyapatite of teeth. This eliminates the need for preceding treatment of the prepared-tooth prior to cementation.\(^6\)

The success of any substance is evaluated by its durability, capacity to seal plus biocompatibility exhibited in the oral cavity. Microleakage is judged to be a significant aspect that controls the long life of dental restorations. Thus the current in-vitro research was performed to assess the marginal integrity as well as microleakage of ceramic crowns luted with different adhesive cements by using stereomicroscope.

**MATERIALS AND METHODS:**

**Sample Collection:**
Sixty healthy premolar teeth that were subjected to extraction for the purpose of orthodontic treatment were included in this research. The exclusion criteria were premolars with dental caries and/or restorations. With the use of hand as well as ultrasonic equipments, dental plaque, calculus as well as periodontal tissues were cautiously detached from the tooth surface. Growth of bacteria was prevented by storing the teeth in 0.5% chloramine T solution at 4°C.

**Tooth preparation and fabrication of crowns:**
A calibrated and trained researcher performed single crown restoration preparation by means of diamond rotary burs with standardized diameters beneath continuous water cooling. In order to calibrate the preparations, the design margin comprised of 1 mm circumferential rounded chamfer, rounded cavo-surface angles to avoid stress absorption; axial diminution of 1.5 mm; occlusal lessening of 1.5-2 mm (to attain anatomic shape); plus entire occlusal convergence angle of six degrees. The cervical borders were positioned in enamel and trailed the CEJ; following which they were subjected to polishing by the use of fine as well as extra-fine diamond burs. Milling of lithium-di-silicate crowns was executed. The milling factors as delineated are as follows: spacer 80 μm, plus circular margin width of 150 μm. Step bur 12S in addition to cylinder pointed bur 12S were employed in accordance with the typical manufacturer’s recommendations. The fit of the crown restorations analogous to the prepared abutment tooth was tested by a master dental technician.

**Cementation of crowns:**
The 60 specimens were randomly assigned to one of the following three groups (20 premolar samples each), with every group employing a different luting cement.

**Group A: A dual cure resin cement:**
Cementation of the ceramic crown to each prepared sample tooth was done using a dual cure resin cement. In accordance with the manufacturer’s recommendations, equivalent length of the cement was bestowed employing the unique auto-dispense characteristic of the resin tube on to the pad used to mix the luting cement. Soon after mixing, the cement was coated on to the inside surface of the crowns. A ten minute finger pressure was applied on the prepared sample tooth for luting the crowns. Buccal, lingual, mesial and distal tooth-crown borders were subjected to light curing for a period of twenty seconds, at a millimeter distance and the surplus cement at the borders was eliminated.

**Group B: Glass ionomer luting cement:**

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One spoonful of the powder plus two liquid drops was used to mix the Glass ionomer luting cement. Division of the powder into two parts is suggested by the manufacturer. Thus, prior to addition of the second part, the major part of the mixing pad was used to mix two liquid drops with one powder part for ten seconds. Utilizing a spatula, this mixed paste was placed within the crown to position it on the abutment.

**Group C: Self cure resin cement:**
Direct dispensing of the self cure resin cement was done on the bonding surface of the restoration.

**Procedure for thermocycling and dye penetration:**
Each premolar specimen was subjected to thermocycling at 5°C ± 2°C along with 55°C ± 2°C for five hundred cycles. The dwell period in each bath as well as the time break at room temperature concerning baths was sixty seconds. Each sample that had been painted was immersed in 1% methylene blue solution for 24 hours to allow dye-diffusion within any likely spaces amid the crown and the tooth. Following dye-immersion, the specimens were washed and rinsed using distilled water.

**Evaluation of microleakage using stereomicroscope:**
The premolar specimens were subjected to cleansing beneath water to eliminate any surplus dye. A sagittal cross-section of each sample was done with a high-speed diamond wheel disc, 0.01 mm thick employing a tooth-cutting lathe. Sectioned teeth were scrutinized below stereomicroscope at 10× magnification by means of image analysis software. Evidence of a blue-color response on the tooth-cement edge substantiated microleakage.
Microleakage models were completely recorded on the buccal and lingual borders and mesial and distal margins.

Microleakage scoring was done employing Tjan’s et al. criterion:
Score 0= Absence of microleakage;
Score 1= Microleakage to 1/3rd of axial wall;
Score 2= Microleakage to 2/3rd of axial wall;
Score 3= Microleakage alongside the complete length of axial wall, and
Score 4= Microleakage above the occlusal surface.

**Statistical Analysis:**
Data management as well as analysis was performed with SPSS version 20.0. The microleakage at tooth-cement edge was evaluated with One-way ANOVA test. Tukey's post hoc test was used for different analogies. A p value less than 0.05 was set to determine statistical significance.

**RESULTS:**
Table 1 depicts the mean as well as standard deviation of 3 different luting cements employed in this research. 1.12 ± 0.09 was the mean value for dual cure resin cement, 2.80± 0.02 for GIC luting group and 1.36± 0.16 for self cure resin cement.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Mean± Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A: A dual cure resin cement</td>
<td>20</td>
<td>1.12 ± 0.09</td>
</tr>
<tr>
<td>Group B: Glass ionomer luting cement</td>
<td>20</td>
<td>2.80± 0.02</td>
</tr>
<tr>
<td>Group C: Self cure resin cement</td>
<td>20</td>
<td>1.36± 0.16</td>
</tr>
</tbody>
</table>

Table 2 shows the comparative evaluation of mean microleakage for the different luting cements used. Amid the luting agents tested, the least microleakage was present in dual cure resin cement group (1.12 ± 0.09), trailed by the self cure resin cement group (1.36± 0.16) and then the GIC luting group (2.80± 0.02). The analysis of variance showed statistically significant differences amid the different luting cements.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean ±Sd</th>
<th>F Value</th>
<th>P Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A: A dual cure resin cement</td>
<td>1.12 ± 0.09</td>
<td>24.124</td>
<td>0.001</td>
<td>HS</td>
</tr>
<tr>
<td>Group B: Glass ionomer luting cement</td>
<td>2.80± 0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3: Multiple Comparisons using Tukey HSD

<table>
<thead>
<tr>
<th>Groups</th>
<th>Compared with</th>
<th>Mean Difference (I-J)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>Group B</td>
<td>-1.68*</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Group C</td>
<td>-0.24</td>
<td>0.162</td>
</tr>
<tr>
<td>Group B</td>
<td>Group A</td>
<td>1.68*</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Group C</td>
<td>1.44</td>
<td>0.001</td>
</tr>
<tr>
<td>Group C</td>
<td>Group A</td>
<td>0.24</td>
<td>0.162</td>
</tr>
<tr>
<td></td>
<td>Group B</td>
<td>-1.44</td>
<td>0.001</td>
</tr>
</tbody>
</table>

*—Highly Significant

Table 4 reveals the division of microleakage scores of different luting cements. Dual cure resin cement group had higher score 0 [11(55%)], Self cure resin cement group [9(45%)] had greater score 1 while score 2 was significant [9(45%)] in the GIC luting group.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Microleakage scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Score 0</td>
</tr>
<tr>
<td>Group A: A dual cure resin cement</td>
<td>11(55%)</td>
</tr>
<tr>
<td>Group B: Glass ionomer luting cement</td>
<td>5(25%)</td>
</tr>
<tr>
<td>Group C: Self cure resin cement</td>
<td>8(40%)</td>
</tr>
</tbody>
</table>

DISCUSSION:

Break down of cement due to disintegration or suspension in oral fluids, setting related shrinkage, potency and waning of the union amid dentine and the cement or between cement and the restoration are documented as probable reasons of microleakage in addition to failure of the resultant bonding.

Arrays of techniques are present for assessing the marginal microleakage vertically like Stereomicroscope, impression replica, cross-sectioning, as well as direct-visualization system. In the present research, stereomicroscope was employed that is a non-invasive measurement technique. Furthermore, direct imaging method beneath microscope using the software for image scrutiny allows a non-damaging quantification plus aids in measuring numerous dimensions.

Thermocycling is a largely adopted technique that replicates the physiological process of aging undergone by biomaterials used in dentistry. Subsequently, it is regularly made use of in research to assess material utility. In the current research, the samples were exposed to 500 cycles ranging between 5 to 55°C to replicate the hot/cold situations in the oral cavity with a dwell span of 1 minute and transfer period of seven seconds.

In this research, the highest microleakage following assessment of the 3 luting cements studied was noted for GIC. The cause for the same can be vulnerability to dissolution owing to premature water exposure as well as resultant poor bonding with dentin. This finding is in harmony with the research of Bhandari S et al. where it was concluded that GIC is highly prone to disintegration at the time and soon after the preliminary setting as it has a delayed setting response in several progressive phases that overlap.

Cement capability in decreasing the quantity of microleakage along the tooth-restoration margin is imperative to a clinically successful outcome. Numerous techniques, to evaluate the degree of microleakage as well as the intactness of restorations at its boundaries have been employed. One among the frequently used procedure is the dye-diffusion technique. Arrays of techniques that quantify the degree of microleakage have been adopted by
research attempting to assess marginal seal. Using multiple dyes, chemical marking agents, isotopes that are radioactive, air-pressure, bacteria as well as electro-chemical procedures are few such techniques. Methylene blue, aniline blue, fluorescein, eosin, erythrosine, as well as the Indian ink are few of the frequently employed dyes. In this study, dye-diffusion method was chosen.

Dual cure resin luting cement exhibited the least microleakage in this research. Next in order were Self cure resin luting and GIC group. This is not in accordance with the research by Piwowarczyk et al., wherein the lowest microleakage was noted with a self-adhesive resin cement in contrast with the other evaluated cements used in enamel/dentin. This was attributed to low leakage in the self-adhesive cements that results from absence of dissimilar interfacial bond-layers that negotiate adaptability.

H. Heshmat et al. have cited that self-adhesive resin cements exhibit greater microleakage at both enamel as well as dentin borders. This contrast finding could be due to the fact that in Piwowarczyk’s study, these cements were employed in luting crown restorations with gold alloys. Encouraging adaptation of the gold alloy to tooth surface as compared to other restorations, result in a lowered thickness of cement, thus reducing shrinkage arising from polymerization.

Ebadian B et al. in-vitro research pertains to the link amid microleakage as well as total marginal inconsistency in crowns cemented with 4 different resin cements. The dual cure adhesive cement depicted the least score of microleakage. Al-Haj-Ali et al. also achieved alike results in spite of the assessment being made on metal crowns. This study indicated that the impermeability was greater in resin cement as compared to GIC.

Evaluation performed in lab conditions was the major limitation of this research; nevertheless the immaculate manner of testing dental cements shall be in the oral environment. Further clinical skill is required to validate the results in actual clinical circumstances. The critical characteristics like robustness of cements, strength plus margin-adaptability must be judged clinically.

CONCLUSION:
Considering the limitations of this research, a conclusion that dual cure resin luting cement group reveal appreciably lesser microleakage compared to self-cure resin cement group and glass ionomer luting cement group.

REFERENCES: