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Comparative evaluation of marginal integrity of three esthetic restorative materials in class V cavities under stereomicroscope: an in-vitro study.

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ABSTRACT

Aims*: The aim of this invitro study was to compare the marginal integrity among three esthetic restorative materials.*

Methods and Material*: This study was conducted on 60 freshly extracted human premolars in which Standardized Class V cavities were prepared. Teeth were equally assigned to three groups : GC- Aenial Anterior Composite(Group A), Tetric N- Ceram(Group B), Palfique LX5(Group C). Each group containing 20 teeth were restored and then stored in distilled water for 1 week at 37˚C. The specimens were dried and painted with two coats of nail varnish on the teeth except 2mm around the cervical margins of the restoration and air dried. After that the teeth were kept in 2 % methylene blue solution for 24 hours. After sectioning the teeth, the sectioned halves were then evaluated for dye penetration under stereomicroscope.*

Statistical analysis used*: The statistical analysis was performed using the Kruskal-Wallis test along with post hoc pairwise comparison by Mann Whitney U test.*

Results: *The findings suggested that Tetric N-Ceram was superior to the other two composite materials*

Conclusions: *Marginal leakage scores of novel restorative material, Tetric N- Ceram was minimal and within acceptable limits compared to other tested material.*

Key-words*: Esthetic, Marginal integrity, Methylene Blue, Stereomicroscope.*

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I. Introduction:

Microleakage is defined as the passage of fluids and substances through minimal gaps on the restoration-teeth interface. In theory, microleakage is deemed as an indication of failure because it reduces the sealing's effectiveness, compromises the restoration, and increases the chances of secondary caries and post-operative sensitivity.[1] The marginal integrity is the interface between the restoration and dental hard tissue and is an area of clinical concern as insufficient sealing can lead to hypersensitivity, marginal discolouration, secondary caries and pulpitis due to microleakge.[2] The marginal leakage, mainly in restorations with cervical margin in dentin, is considered responsible for hypersensitivity, secondary caries, marginal discoloration, and pulpal pathologies. Marginal sealing is known to influence the longevity of dental restorations.[3]

Composite resin materials have progressed from macrofills to microfills and from hybrids to microhybrids, and new materials such as packable and nanofilled composites have been introduced to the dental market.[4] One of the most important advances in recent years is the application of nanotechnology to resin composites. Nanotechnology is known as the production of materials and structures in the range of about 0.1–100 nm by various physical and chemical methods. The size of the filler particles lies around 8–30 μm in hybrid composites, and 0.7–3.6 μm in microhybrid composites, new fillers with size ranging from around 5–100 nm have been developed which are incorporated in nanohybrid composite resin.[5]

The most important factors affecting the restoration's clinical success is the sealing of the margins and its adaptation as well as the type of adhesive system used in bonding procedure.[6] Other factors include: the degree of shrinkage stresses, finishing and polishing of the restoration.[7]

GC G-aenial is a light cured, radiopaque hybrid composite restoration with diverse multifaceted particles and combination of fillers – its size and distribution within is carefully calculated so that when combined, it contributes to its low level shrinkage and provides best aesthetic results.

Newly introduced Tokuyama Palfique LX- 5 is a resin based restorative material infused with Supranano spherical materials. It is widely in use today due to its superior properties like high wear resistance, low wear to opposing teeth, low polymerization shrinkage and good radiopacity.

Good sealing ability of Nanoionomer (Tetric N-Ceram) may be related to high filler loading and lower coefficient of thermal expansion which compensates polymerization contraction stresses.[8]

The aim of this invitro study was to evaluate and compare the marginal integrity of three esthetic restorative materials, namely, Tokuyama Palfique LX-5, Ivoclar Tetric N-Ceram, and GC G- Aenial anterior composite using dye penetration method under stereomicroscope.

II. Subjects and Methods:

The study was conducted on 60 human maxillary and mandibular premolars. The premolars that were extracted for orthodontic purposes were used. The teeth that were free from any sort of carious lesion were chosen. Tooth with any root filling, fracture, caries and cracks were excluded from the study. Until further use, all teeth were kept at the room temperature in physiological state.

Sample Preparation

On each premolar, class V cavities were prepared with butt joint margins and 5-mm mesio-distal width, 2 mm in-depth, 3 mm in occluso gingival height. Access was gained through enamel with a round diamond bur and the preparation were completed with the same. The preparations were performed using high-speed ranges under abundant air-water coolant. **(Figure 1a.)**

Sample grouping

All the sixty samples were divided into three groups, with 20 samples per group (n= 20). Later, each group was restored with the respective composite material**(Table 1).**

TABLE 1.

Group I: GC G-Aenial anterior composite	Group I (N=20) teeth were restored with GC G-Aenial anterior composite using Nanobond Universal Adhesive (Waldent) adhesive system in 2mm increments
Group II: Tetric N-Ceram	Group II (N=20) teeth were restored with Tetric N-Ceram using Nanobond Universal Adhesive (Waldent) adhesive system in 2mm increments.
Group III: Tokuyama Palfique LX-5	Group III (N=20) teeth were restored with Tokuyama Palfique LX-5 using Nanobond Universal Adhesive (Waldent) adhesive system in 2mm increments.

After completion of the restorations **(Figure 1b & c.)**, the restorations were finished and polished using Shofu Composite polishing kit. Restored teeth were then stored in distilled water for a week and then apices of teeth were sealed using sticky wax, and the specimens were coated with two layers of nail varnish, leaving a 1 mm window around the restoration margins.

Sample preparation for Stereomicroscopic evaluation

The samples were then immersed in 2% of methylene blue dye for 48 hours. After removal from the dye at the specified time, the samples were cleaned under running water for two minutes and dried completely. Then the teeth were sectioned buccolingually through the centre of the restoration with a water cooled diamond disk to obtain two sections from each. **(Figure 1d.)** Dye penetration were examined at occlusal and cervical margins using Stereomicroscope under 20x magnification.**(Figure 2.)**

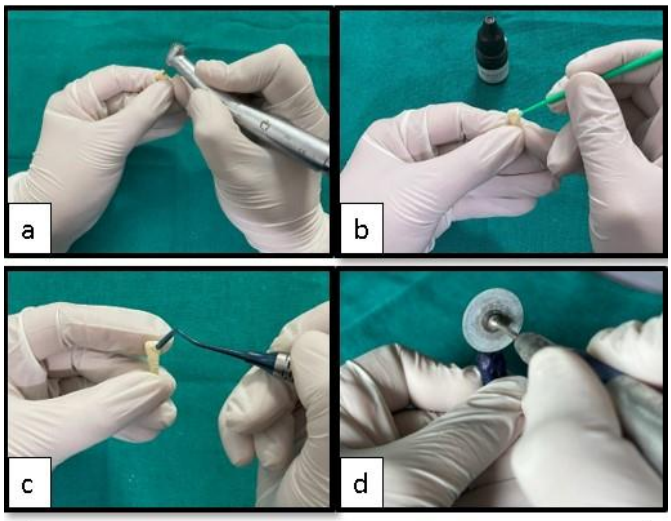

Figure 1. Cavity Preparation and Sectioning

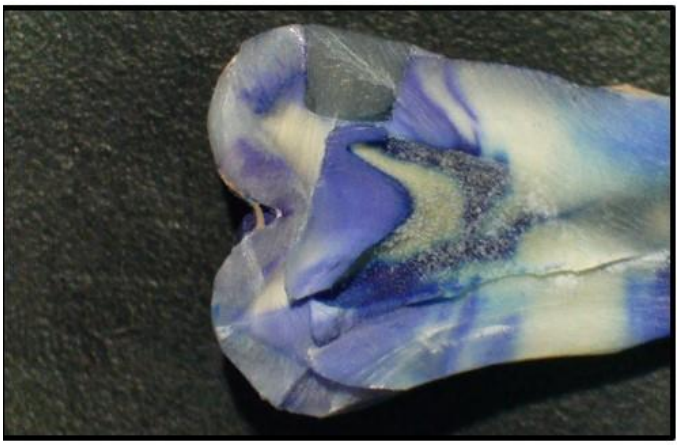

Figure 2. Sectioned tooth under Stereomicroscope

Microleakage measurement was done according to the penetration of dye along the tooth restoration interface and were graded according to criteria described by Khera and Chan in 1978.

score 0 : no leakage

score 1 : leakage less than or up to one half of the depth of the cavity preparation

score 2 : leakage more than one half of the cavity preparation involved, but not up to the junction of the axial wall and occlusal or cervical wall

score 3 : leakage up to the junction of the axial wand occlusal or cervical wall, but not including the axial wall

score 4 : leakage due penetration, including the axial wall

III. Results:

According to the results of our study, at the occlusal level, the values of dye penetration were compared and it was found out that Score 0 was found to be more among Group B, score 1 was found to be more among Group C, score 2 was found to be more among Group C, score 3 was found to be more among Group A, and score4 was found to be more among Group A.

At the cervical level, the distribution of different dye penetration scores among the three study groups was significantly different. Score 0 was found to be more among Group B, score 1 was found to be more among Group C and Group B, score 2 was found to be more among Group C, score 3 was found to be more among Group C, and score 4 was found to be more among Group A.

TABLE 2: Intergroup comparison of Mean dye penetration scores at occlusal level

Group	*n*	Mean	Std. Deviation	*P*[b]	*Post hoc* pairwise comparison[c]
Group A	40	1.73	1.710	<0.0001*	Group A * Group B<0.0001*
Group B	40	0.35	0.736		Group A * Group C-0.409
Group C	40	1.15	1.027		Group B * Group C<0.0001*

[b]Kruskal Wallis test, [c]Mann Whitney U test, *Statistically significant.

TABLE 3: Intergroup comparison of Mean dye penetration scores at cervical level

Group	*n*	Mean	Std. Deviation	*P*[b]	*Post hoc* pairwise comparison[c]
Group A	40	3.03	1.609	<0.0001*	Group A * Group B<0.0001*
Group B	40	0.75	1.428		Group A * Group C-0.01*
Group C	40	2.58	1.259		Group B * Group C<0.0001*

[b]Kruskal Wallis test, [c]Mann Whitney U test, *Statistically significant.

At the occlusal level, intergroup comparison of mean dye penetration scores was performed using Kruskal–Wallis test, and a statistically significant difference was found between them. Mean dye penetration scores among Group A and Group C samples were found to be significantly more than that among Group B samples. No statistically significant difference could be found between Group A and Group C samples with respect to the mean dye penetration score **(Table 2).**

At the cervical level, intergroup comparison of mean dye penetration scores was performed by using the Kruskal Wallis test, and a statistically significant difference was found between them. Mean dye penetration scores among Group A was found to be significantly more than that among Group C, which was further significantly more than that among Group B samples **(Table 3).**

IV. Discussion:

In dentistry, several restorative materials have been tried and used but currently the use of composites has gained in prominence because of it's perceived advantages like micro-mechanical bonding to the tooth structure, higher fracture resistance than other comparable restorative materials and also in having the core advantage of being a resin-based restorative. It successfully and satisfactorily meets the functional and the esthetic demand of the patient.[9]

Bonding of restorative material to tooth structure should eliminate any gaps if present. Good adhesion between composite resin and dentin is a crucial factor in increasing the life of restoration. Bonding of composite resins to dentin is influenced by various factors such as cavity configuration, dentin depth, curing behaviour of composites, type of adhesive system and type of composite material. The shrinkage stress generated during curing influences the marginal integrity of the restoration and is in turn affected by the C-factor.[10]

This invitro study aimed at evaluating the microleakage among three restorative material, GC G-Aenial Anterior Composite, Tetric N Ceram, Tokuyama Palfique Lx-5 after restoring class V cavities and then carrying out the microleakage test.

Methylene blue dye was used in this study since its molecular size is as low as 1 nm which is smaller than the diameter of dentinal tubule and can thus penetrate through the smallest of gaps between the restoration and tooth interfaces.[11]

This study illustrated that Tetric N-Ceram, exhibited least microleakage and good marginal integrity along its restoration borders. In terms of microleakage, Tokuyama Palfique came second and third was the composite resin G-Aenial.

However, the difference between the two materials was not statistically significant. The Tetric N-Ceram resin composite utilized in the study contains camphoroquinone as the main photoactivator, which absorbs blue wavelengths ranging from 420 to 495 nm, the Tetric N-Ceram resin composite is classified as a nano-hybrid, medium viscosity bulk fill material. "Nano-hybrid" indicates that the composite contains nanoscale filler particles dispersed within the resin matrix. The Tetric N-Ceram resin composite contains a patented light activator called Ivocerin. Ivocerin ensures the complete curing of the filling material when exposed to the appropriate curing light.[12]

The results of our study are in conjunction with the study done by **Priya Badkul et al.** who evaluated microleakage among newer composites in Class II cavities by dye penetration method and concluded that Tetric N-Ceram resin composite exhibited a lower degree of microleakage in both the occlusal (biting surface) and cervical (gum line) areas compared to other resin composites.[13]

The other findings regarding the material GC G-Aenial anterior composite stated that this material exhibited more microleakage than Tetric N-Ceram in this study. A study done by **Sukhdeep Singh et al.** in the year 2021 explained that polymerization shrinkage may be the reason for this finding. Contemporary composite materials shrink during polymerization, resulting in a volumetric reduction ranging from 1.5 to 5% depending on the molecular structure of the monomer, the amount of filler, and the rate of cure.[14]

GC G-AENIAL and Tokuyama Palfique LX5 showed high levels of dye penetration both at the occlusal and gingival margins compared to Tetric N-Ceram. The difference was statistically significant overall microleakage scores as well as intergroup microleakage scores. The reason behind these results may contribute to the properties that Estelite Palfique LX5 is made of TEGDMA and Bis-GMA. Bis-GMA has lower water solubility and absorption properties, while TEGDMA is a more hydrophilic monomer that shows water absorption. Composites containing TEGDMA show a general relationship wherein the storage modulus decreases with immersion time proportionally to the absorbability of the material. Hydrophilic groups such as the ethoxy group in TEGDMA are thought to show affinity with water molecules by hydrogen bonding.[15]

With the introduction of newer materials claiming superior properties, it becomes imperative to evaluate them, especially in relation to their marginal integrity, to be able to use them predictably. Hence, this study was undertaken to evaluate the marginal integrity of new restorative materials available in the market.

V. Conclusion

Within the limitation of this in vitro study it can be concluded that :

- None of the restorative systems tested totally prevented microleakage in class V restorations regardless Tetric N- Ceram showed least microleakage comparatively.
- There was a statistical significant difference in microleakage among Tetric N- Ceram and GC Aenial Composite and Tokuyama Palfique but no significant difference between the latter two groups in terms of microleakage.
- Tetric N Ceram performed better than Tokuyama Palfique in Cervical margin.
- GC Aenial Composite showed maximum microleakage when compared to Tetric N- ceram.
- Marginal leakage scores of novel restorative material, Tetric N- Ceram was minimal and within acceptable limits.
- Compared to other tested material, it can be a good choice of restorative material for class V cavities.
- Tetric N- Ceram offers a promise for future as direct posterior restorative material.

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