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Evaluation the immediate and delayed micro-leakage of three restorative materials to fill class II cavities in molar teeth

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***Abstract*---Aim:** The current research aimed to evaluate the Immediate and Delayed micro-leakage of three restorative materials (Group I: Activa™ BioActive, Group II: Tetric N Ceram Bulk fill, and Group III: Ever X Posterior) in Class II cavities. **Method:** 30 human permanent lower molars were selected to be utilized in the current research. Class II cavities in the mesial surface were prepared. After that, the molars were randomly split into the three main investigational groups according to the type of composite restoration (n=10) teeth for each group. Next, two subgroups (n=5) were created from every main group; subgroup 1 immediate leakage test (without storage) and the molars specimens within subgroup 2 delayed leakage

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test (were kept in normal saline for 28 days within the incubator at 37 °C ± 1°C and relative humidity 95%.): **Group I: Activa™ BioActive, Group II: Tetric N Ceram Bulk fill, and Group III: Ever X Posterior**. Every tooth specimen was subjected to 1000 heat cycles with a dwell time of 30 seconds among 5° and 55°C. Then, the specimens were immersed in a 1% aqueous solution of methylene blue dye for 8 hours. Three millimeters below the cement-enamel interface, the roots of the teeth were cut. After that, the crowns are divided longitudinally (mesio-distal). The International Organization for Standardization's scoring method was used to measure the linear penetration of silver nitrate beneath a stereomicroscope connected to a digital imaging device at a 20X magnifying level in order to quantify the leakage. **Results:** In concerning the Immediate micro-leakage test: Group I (Activa™ BioActive) had the lowest reported mean micro-leakage values (0.60±0.73), followed by Group II (Tetric N Ceram Bulk fill) recorded 0.70±0.51, while Group III (Ever X Posterior) recorded the highest micro-leakage values 1.90 ± 0.66. Statistically, there was statistically significant variation across Group III and other two groups (p = 0.005), while there was no statistically significant different among group I and group II (P = 0.213). While in concerning the Delayed micro-leakage test: Group I (Activa™ BioActive) had the lowest reported mean micro-leakage values (0.45±0.55), followed by Group II (Tetric N Ceram Bulk fill) recorded 0.60±0.51, while Group III (Ever X Posterior) recorded the highest micro-leakage values 2.10±0.87. Statistically, there was statistically significant variation across Group III and other two groups (p = 0.005), while there was not statistically significant different among group I and group II (P = 0.213). On other hand there were no statistically significant variation across the Immediate and Delayed micro-leakage for each group (P = 0.213). **Conclusion:** In Class II cavities, the application of bioactive restorative systems leads to a notable decrease in marginal microleakage when compared to the utilization of a universal hybrid composite resin.

***Keywords*---**micro-leakage, fill class II cavities, molar teeth.

Introduction

Composite restorative materials have been subjected to great modifications to their adhesive steps, inorganic fillers, and chemical makeup which made important changes Developments in Operative Dental field. Nowadays the Composite resin is the most utilized restoration because of the aesthetical demands, adhesion dental tissue, and mechanical properties [(1,2)].

One of the primary reasons why restorations fail is still microleakage. The transfer of germs, fluids, chemicals, and/or ions through the tooth and restorative borders is known as microleakage [(3)]. Numerous negative consequences, including secondary caries, increased sensitivity of the treated tooth, and interfacial discoloration resulting in pulp disease, can be brought on by microleakage [(4,5)].

There have also been reports of nano leakage, another kind of leaking. Fluids passing through the connection among dentin and restorative resin is known as nano leakage. It is mostly brought on by dentin acid etching, which can allow oral and dentinal fluids to enter the hybrid layer [6,7].

It is commonly recognized that microleakage can result in postoperative hypersensitivity, and discomfort and that it impacts the tooth pulp's health [8], So, the marginal adaptation was the main problem with composite restoration due to polymerization shrinkage but now there are types of composite resins that have decreased polymerization shrinkage to improve the materials' longevity and lessen cusp deflection, after filling hypersensitivity, and gap development [9,10].

Various methods for evaluating microleakage have been created and applied. There are benefits and downsides to these tests, which include dyes, radioactive isotopes, air pressure, bacterial activity, neutron activation analysis, scanning electron microscopy, dye penetration, and microcomputed tomography (μCT) [11].

So, the present research designed to evaluate the Immediate and Delayed micro-leakage of three resin composite restorations (Activa™ BioActive, Tetric N Ceram Bulk fill, and Ever X Posterior) in Class II cavities in the mesial surface of molar teeth.

Materials and methods

Teeth selection

From the outpatient clinic of the Faculty of Dental Medicine at Al Azhar University, thirty recently extracted undamaged, caries-free, and restoration-free human permanent molars were gathered. Periodontal problems were the cause of the extraction. A manual scalar (Nordent, Ivory #2&3, USA) was used for eliminating calculus and soft-tissue deposition.

When examined beneath a stereomicroscope (Optika, Italy) at 10X magnification, the chosen molars showed no signs of fissures, previous restorations, or flaws. The molars were kept in a screw-capped glass jar containing distilled water at the ambient temperature (23±2°C) for two weeks while they were sterilized in a 0.1% thymol solution [12].

Specimen preparation:

Class II cavities in the mesial surface were prepared as the subsequent measurements, with the gingival Cavo surface edge 1 mm over the CEJ: occlusal depth = 2 mm, bucco-lingual breadth = 2 mm, and axial depth = 4 mm [13]. With the use of a modified dental surveyor, uniform cavities were prepared at fast speed using an air/water spray and a diamond fissure bur (Komet, Germany) with a parallel sided (1.2 mm) diameter. Four cavities were prepared with each fresh bur, followed by waste, to guarantee good cutting performance.

After that, the molars were randomly split into the three main investigational groups according to the type of composite restoration (n=10) teeth for each group. Next, two subgroups (n=5) were created from every main group; subgroup 1 immediate leakage test (without storage) and the molars specimens within subgroup 2 delayed leakage test (were kept in normal saline for 28 days within the incubator at 37 °C ± 1°C and relative humidity 95%.):

Group I: Activa™ BioActive:
Following the supplier's recommendations, the cavities were immediately repaired with ActivaTM BioActive (Pulpdent Corporation, Watertown, MA, USA) after being etched for five seconds using Decrey Conditioner 36, Dentsply. Activa bioactive was used as a bulk filling material and was cured via the following procedure: occlusal curing = 40 s. Following that, the matrix band was removed, the fillings were light-cured through the buccal and lingual surfaces for an extra 20 seconds on every side utilizing an LED light curing device (Woodpecker® Dental Curing Light LED D) with an output irradiance of roughly 850-1000 mW/cm2 held in contact with the occlusal edge of the matrix band.

Group II: Tetric N Ceram Bulk fill:
The cavities were filled with the appropriate bulk-fill resin composite, Tetric N Ceram bulk-fill, after being etched for 15 seconds using Detrey Conditioner 36, Dentsply, and then bonded and cured for 10 seconds using Adper Single Bond 2, 3M ESPE. The same curing technique as Group I was used.

Group III: Ever X Posterior:
After 15 seconds of etching (Detrey conditioner 36, Dentsply), the cavities were filled with a bonding agent (Adper single bond 2, 3M ESPE) and allowed to dry for 10 seconds. The cavities were then filled with the appropriate Ever X Posterior (GC Corp., Japan). The same curing technique as Group I was used.

Thermocycling process:
Every tooth specimen was subjected to 1000 heat cycles with a dwell time of 30 seconds among 5° and 55°C [14]. The molars specimens in subgroup 1's immediate leakage test were then not stored, whereas those in subgroup 2's delayed leakage test were kept in normal saline for 28 days at 37 °C ± 1 °C and 95% relative humidity in an incubator [15] In accordance with the storage duration, both subgroups were then submitted for microleakage investigation.

Microleakage analysis

Utility wax was used to seal the root apices, and two coats of nail varnish were applied over the whole tooth surface up to one millimeter from the restoration. After being submerged in a 1% aqueous solution of methylene blue dye for eight hours at the ambient temperature, the samples were carefully washed to get rid of any remaining dye.

Sectioning procedure: Three millimeters below the cemento-enamel interface, the tooth roots were cut. Two equivalent dental pieces (two sections per tooth) are obtained by sectioning the crowns longitudinally (in the mesio-distal direction) using a diamond disc in a slow-speed handpiece and sufficient irrigation. Under

a spray of water, silicon carbide sheets are used to polish the sliced surfaces for two minutes before they are dried.

Scoring and leakage estimation: The International Organization for Standardization (ISO/TS 11405: 2003) offered a scoring system that was used to measure the linear penetration of silver nitrate beneath a stereomicroscope connected to a digital imaging device at a 20X magnification level. The following is an illustration of the score system:[16]
Score 0: No penetration of dye.
Score 1: Half of the gingival floor has dye penetration.
Score 2: More than 50% of the gingival floor has been dyed without penetrating the axial wall.
Score 3: Dye infiltration into the axial and gingival walls.

Statistical analysis

"SPSS software" was used to calculate the statistical analysis (SPSS version 20, IBM, USA). At the 0.05 significant level, the findings were examined using the Kruskal-Wallis, Mann-Whitney U, and Wilcoxon Signed Ranks tests.

Results

The means and standard deviations of micro-leakage tests were represented in Table (1) and illustrated in Figure (1).

In concerning the Immediate micro-leakage test:
Group I (Activa™ BioActive) had the lowest reported mean micro-leakage values **(0.60±0.73),** followed by Group **II (Tetric N Ceram Bulk fill)** recorded **0.70±0.51**, while **Group III (Ever X Posterior)** recorded the highest micro-leakage values **1.90 ± 0.66.** Statistically, there was statistically significant variation across **Group** III **and** other two groups (p = 0.005), while there was not statistically significant different among groups I and II (P = 0.213).

In concerning the Delayed micro-leakage test:
Group I (Activa™ BioActive) had the lowest reported mean micro-leakage values **(0.45±0.55),** followed by Group **II (Tetric N Ceram Bulk fill)** recorded **0.60±0.51**, while **Group III (Ever X Posterior)** recorded the highest micro-leakage values **2.10±0.87.** Statistically, there was statistically significant variation across **Group** III **and** other two groups (p = 0.005), while there was not statistically significant different among groups I and II (P = 0.213).
On other hand there were no statistically significant variations across Immediate and Delayed micro-leakage for each group (**P = 0.213)**.

Table (1) Showing the mean and standard deviation of Immediate versus Delayed micro-leakage test for all different groups

Groups	means ± standard deviations		P value
	Immediate	Delayed	
Group I: Activa™ BioActive	0.60±0.73^{B}	0.45±0.55^{B}	P = 0.213
Group II: Tetric N Ceram Bulk fill	0.70±0.51^{B}	0.60±0.51^{B}	

Group III: Ever X Posterior	1.90 ± 0.66[A]	2.10±0.87[A]	
P value	P = 0.005		

Significant differences are indicated via various letters.

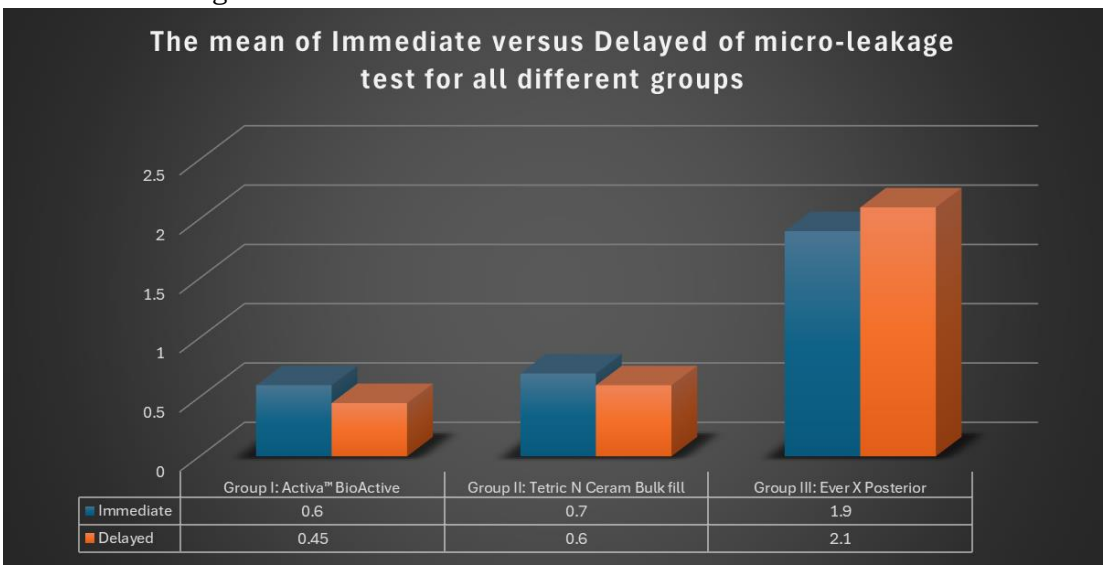

Figure (1): A Chart showing the means of Immediate versus Delayed micro-leakage test for all different groups

Discussion

Over the past few years, dental restorations like as resin composites and adhesive systems have advanced. Various physical qualities and material elements, such as packability, flowability, varied insertion strategies (bulk vs. incremental), and unique restorative delivery mechanisms (thermal and/or acoustic energy), have been widely depended upon in marketing solutions. Several of these types of restorations, although being distinct and user-specific, have demonstrated encouraging but conflicting results with respect to marginal microleakage [17,18].

On this way, the present research designed to assess the Immediate and Delayed micro-leakage of three resin composite restorations (Group I: Activa™ BioActive, Group II: Tetric N Ceram Bulk fill, and Group III: Ever X Posterior) in Class II cavities in the mesial surface of molar teeth. In this study we used dye penetration to evaluate the micro-leakage of margin adaptation of the restorative materials to detect its sealing qualities [13].

<u>The outcomes of this research concerning the Immediate micro-leakage test:</u>

Group I (Activa™ BioActive) had the lowest reported mean micro-leakage values followed by Group **II (Tetric N Ceram Bulk fill)**, while **Group III (Ever X Posterior)** recorded the highest micro-leakage values**.** Statistically, there was statistically significant variation across **Group** III **and** other two groups (p = 0.005), while there was not statistically significant different among groups I and II (P = 0.213).

In the present study, the cause of the highest leakage of the **ever X Posterior** this may be clarified through the fact that the degree of contraction stress has a significant impact on the material's visco-elastic characteristics, and ***Papadogiannis et al. (2015)*** found that adding fibers to composite materials increases their modulus, which in turn results in the highest viscosity. This might thus hinder the material's ability for adaptation against the cavity walls [19].
On other hand the ionization reaction that aids in the formation of a hydroxyapatite bond to the tooth structure may be responsible for the better sealing of **ActivaTM BioActive**, whereas the developed photointiator ivocerin and the formulation's shrinkage stress relievers may be responsible for the improved seal achieved in **Tetric N Ceram bulk fill** [20].

The present research supports the findings of ***Fronza et al. (2015)***, who discovered that Ever X Posterior formed an elevated gap percentage with elevated polymerization stress in comparison to other bulk fill composites **(Tetric Evoceram, SDR, and Filtek Bulk-Fill)**. This could be because of its high inorganic content and consequently high elastic modulus [21].

In concerning the Delayed micro-leakage test:

The results were in the same order of the Immediate micro-leakage results but in less mean values.
Statistically, there was statistically significant variation across **Group** III **and** other two groups (p = 0.005), while there was not statistically significant different among groups I and II (P = 0.213).
On other hand there were no statistically significant variations across Immediate and Delayed micro-leakage for each group (**P = 0.213)**.
The reduction in Delayed micro-leakage results of **Activa™ BioActive** may explain because the release of phosphate and calcium ions, which can promote the development of mineral apatite and remineralization at the restoration-tooth contact. In the field, this bioactivity has been shown to improve the bond between the filling and the tooth and to seal the margins against microleakage [22].
McCabe et al. (2011) and Hamdy et al. (2018) reported similar bioactivity, stating that bioactive materials can create an apatite-like coating on their surface after being submerged in simulated bodily fluids like PBS, protecting the tooth structure [23,24].

Conclusion

In Class II cavities, the application of bioactive restorative systems leads to a notable decrease in marginal microleakage when compared to the utilization of a universal hybrid composite resin.

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