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Evaluation of Microleakage of Class II Restorations Using Various Restorative Materials – A Comparative Invitro Study

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Abstract

The quest for a suitable esthetic material to restore teeth has led to substantial improvements in their properties and application technique. Two major advances in esthetic restorative dentistry are composites and acid-etch techniques. The aforesaid hypothesis was put to test in this study by comparing the marginal leakage of amalgam, packable composite, flowable composite with packable composite and high-viscosity conventional gic

Methods: 60 freshly extracted teeth were selected and divided into 4 groups of 15 teeth each. Standardized class ii cavities were prepared. Cavities in group i were restored with amalgam, group ii were restored with packable composite (gc g- aenial posterior), group iii with flowable composite(g-aenial universal flo) as liner and then restored with packable composite(gc g- aenial posterior) and group iv with high-viscosity conventional gic (equi forte fill). The restorations were then subjected to thermo cycling procedure. The specimens were immersed in 0.5% methylene blue dye followed by mesiodistal sectioning of the specimen for the evaluation of microleakage at the gingival margin. The sections were then evaluated under stereomicroscope. The scoring was done according to the level of dye penetration.

Results: amalgam (control group) showed no microleakage and the difference between the control group and the experimental groups were statistically significant **($p<0.017$).**

Interpretation & conclusion: glass hybrid restorative system showed lesser gingival microleakage than resin based restorative material, thereby having better sealing ability. However, clinical acceptability of glass hybrid

restorative systems has to be verified with larger sample size and with in-vivo studies.

Keywords: Gingival Microleakage, Amalgam, Equi Forte Fill, G-Aenial Universal Flog Aenial Posterior, Stereomicroscope

Introduction

A healthy mouth is essential for a sustainable quality of life. Conservation of tooth structure is of paramount importance within the current age of adhesive dentistry or micro dentistry. Instead of using extension for prevention as a treatment guideline, focus is now placed on restriction with conviction.[1]

In order to increase the longevity of the restoration, the integrity and durability of the marginal seal is critical. One of the weak links with class ii composite resin restorations is microleakage at the gingival margin of the proximal box which contributes to postoperative sensitivity, high incidence of secondary caries accounting for several clinically failed restorations.[2,3]despite new innovations, microleakage continues to be one of the main factor for failure in restoration.

A marginal microleakage couldbe process that involves cli nically undetectable bacterial penetration, metabolites, enz ymes, contaminants, ions, and other cariogenic factors bet ween the filling and the cavity wall [4, 5].the choice of restorative material must be based on the performance of the material under simulated and clinical conditions.

Dental amalgam remains as a predominant filling material for load bearing areas. Varnish liner has been used under amalgam restoration to reduce microleakage,[6] but its effectiveness to provide long-term seal is still a concern. Amalgam surface corrosion and deposition of oxides improve marginal auto-sealing over time.[8] in contrast to composite resins, amalgam is dimensionally stable.

Microleakage of posterior restorative materials at the margins of the proximal box specifically at the gingival floor of class ii restorations is a matter of concern to the clinician.[7]it is vital that recently developed restorative materials possess improved physical and mechanical properties, as well as effectively seal the cavity restoration margin, thereby accelerating the performance of restorative materials under oral conditions. Therefore, this study aimed to assess the in-vitro microleakage of class ii restorations with 4 different restorative materials.

Materials and methods

A total of 60 freshly extracted human maxillary premolar teeth following the extraction for orthodontic purposes were collected for this study with consent from the patient's parents approved by the ethical and research committee of the a.j institute of medical sciences and was stored in 0.5% sodium hypochlorite (1:1 dilution of commercial chlorine bleach).

Class ii cavities (box preparation) were prepared using high speedhand piece and diamond burs following the standardized dimensions in each premolar (figure 1)

- Buccolingual width of proximal preparation : 2 mm
- Width of the gingival floor from enamel: 1.5 mm
- Location of gingival seat : at the cej

The buccal and lingual walls of the preparations will be approximately parallel and connected to the gingival wall, with rounded internal line angles. The depth of the cavity will be approximately 1.5 mm, as determined by a william’s periodontal probe.

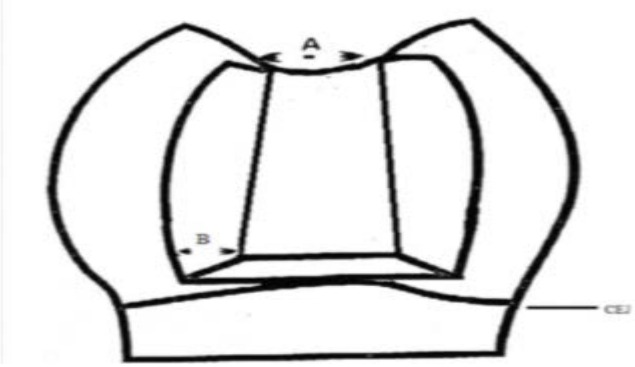

Figure 1: Dimensions of the cavity

The prepared teeth were randomly divided into four groups of 15 (n=15) teeth and were kept in normal saline solution

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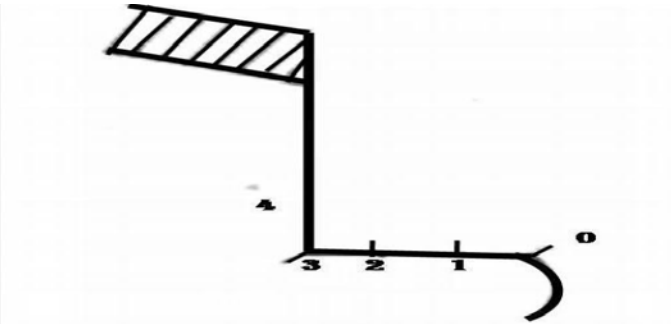
Group I (Amalgam): Tofflemire matrix and retainer were placed around the tooth and held by finger pressure against the gingival margin of the cavity so that the preparation would not be overfilled at the gingival margin. Varnish is applied on all walls and floors of the cavity. Amalgam is then manipulated using amalgamator and placed into the cavity and condensed properly.

Group II (G-aenial posterior restorative): Tofflemire matrix and retainer was placed same as in Group I. Intermediate layer was not used here. The cavities were etched with acid etchant (37% phosphoric acid gel) for 10 seconds, rinsed with water, air dried for 2 seconds. Bonding agent was applied, wait for 10 seconds and air dried for 5 seconds. Then the cavity was restored with packable composite and was light cured for 10 seconds.

Group III (**G-aenial universal flo + Gaenial posterior restorative):** The procedure here is similar to that of Group II till the application of dentin bonding agent. Flowable Composite was placed 1mm then addition of packable composite was done followed by light curing for 10 seconds.

Group IV (Equia- FORTE Fill +Equia- FORTE Coat): Petroleum jelly was applied inside the matrix and conditioned with GC Cavity Conditioner (10 sec) or Dentin Conditioner (20 sec). The cavity was then rinsed and gently dried .The plunger was then depressed and a capsule applier was inserted and activated by clicking once. Mixing for 10 sec. Prime capsule was then immediately dispensed within 10 seconds, packed and contoured. Complete set of EQUIA Forte Fill was ensured. Use a probe to separate the bond between matrix and EQUIA Forte Fill. Finishing of the restoration is done by applying the EQUIA Forte Coat, which is then light cured for 20 sec. The margins of all the restorations were finished with SofLex disks. Restored teeth were then stored in distilled water for a week at Room temperature. The teeth will be thermocycled in water bath maintained between 5°C, 37°C and 55°C. The root apex will be completely sealed with acrylic resin. Each sample will be sealed with two coats of nail varnish, leaving a 1 mm window around the cavity margins. Coated teeth will be then immersed in 0.5% methylene blue dye for 48 hours. Teeth will be rinsed with water and then dried. After removal from the dye solution, the teeth will be sectioned in the mesiodistal direction along the center of the restoration using a slow speed sectioning disc under water irrigation. Each specimen will be examined under a stereomicroscope Standardized digital images were obtained. Grading will be done according to dye penetration



Score 0 — no dye penetration

Score 1 — dye penetration up to one-third of the gingival wall

Score 2 — dye penetration up to two-third of the gingival wall

Score 3 — dye penetration up to full length of the gingival wall

Score 4 — dye penetration up to the whole length of the gingival wall and along the axial wall

Results

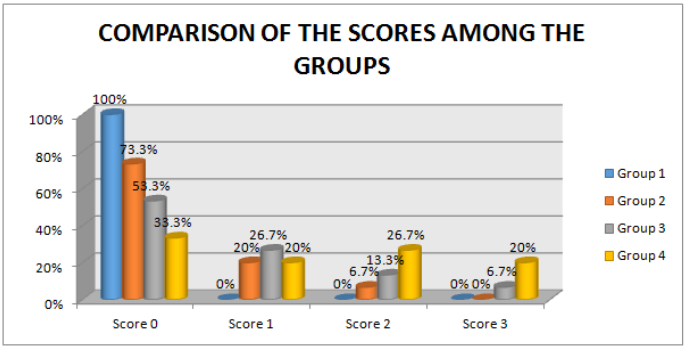
Following the microleakage scores (Table 1, Figure 2, figure 3) and statistical analysis of the values obtained the following observations were made:

Table: 1

		SCORES				Total
		Score 0	Score 1	Score 2	Score 3	
Group 1	Count	15	0	0	0	15
	Percent	100.0%	0.0%	0.0%	0.0%	100.0%
Group 2	Count	11	3	1	0	15
	Percent	73.3%	20.0%	6.7%	0.0%	100.0%
Group 3	Count	8	4	2	1	15
	Percent	53.3%	26.7%	13.3%	6.7%	100.0%
Group 4	Count	5	3	4	3	15
	Percent	33.3%	20.0%	26.7%	20.0%	100.0%
Total	Count	39	10	7	4	60
	Percent	65.0%	16.7%	11.7%	6.7%	100.0%
Chi-square value- 20.12						
P value- 0.017*						

*significant

Figure: 2



When microleakage among the 4 groups were compared, in group1; 15 specimen(100%) showed no microleakage, where as in group 2; 11 specimens(73.3%) showed no microleakage, 3 samples(20%) showed score1 and 1 sample (6.7%) showed score 2. In group 3, 8 samples (53.3%) showed no microleakage, 4 samples(26.7%) showed score 1, 2 samples showed score3 microleakage and 1 sample showed score 1 microleakage. In group 4, 5 samples showed no microleakage, 3 samples with score 1, 4 samples with score3 and 3 teeth showed gingival microleakage past the axial wall. P < 0.017 will be considered as significant.

Discussion

One of the fundamental objective in restorative dentistry is the control of microleakage which can occur due to dimensional changes or lack of adaptation of restorative material resulting in repeated dental caries and pulpal irritation.[9]For improved success rates and reduced p ostoperative sensitivity, marginal discoloration and possibl e secondary caries, the highest marginal quality should be sought. There is a constant search for the material and technique which ensures adhesion to the tooth structure so as to attenuate the potential for leakage. Microleakage tests are widely used to assess the composite restoration marginal sealing.

The increase in demand for tooth-colored restorations in conjunction with concerns about mercury toxicity has reflected in a drastic reduction in the use of amalgam restorations. Resin composites are the most widely used materials as an alternative to amalgam. It is largely due to aesthetic performance, low to no preparation requirement, acceptable longevity, and comparatively low cost.[10] during polymerization, traditional posterior resin composit es undergo volumetric contraction of 2.6 to 7.1 percent. T his shrinkage can lead to microleakage and the sequelae th at follow.[11]The thermal expansion factor of composite resi n (25 to 60 /106/ ° C) is also many times higher than enam el (11.4 /1106/ ° C) and dentin (8 /1106/ ° C). It is also not ed that this physical property is liable for microleakage in resin-based restoration. ***.Alptekin T et al***, conducted in vivo and in vitro studies and concluded that resin composite restorations revealed higher microleakage scores than amalgam restorations.[12] hence, this study was conducted to compare and evaluate the microleakage of amalgam and composite with a glass hybrid restorative system

In the present in–vitro study, group 1and group 4 showed the least microleakage and group 2 showed the highest

microleakage. The current study showed that score zero was predominantly reported for amalgam and Equiforte fill.

A rapid contraction can be observed immediately after packing the amalgam within the cavity, followed by a slower expansion, then a slight and slow contraction.The net contraction and expansion of an amalgam restoration during setting is understood as "dimensional change."

Dimensional change is taken into account negative if the amalgam contracts,and it is considered positive if it expands during setting, but ANSI / ADA specifies that the dimensional change between five minutes and 24 hours must fall within the range of -15 to + 20 μm / cm.

Amalgam does not adhere strictly to the tooth structure; thus, a positive dimension change will end in less space between amalgam and the structure of the tooth.[13]

In a recent study, **Mahler et al** confirmed that zinc in amalgam alloys is responsible for the more rapid corrosion of the sealing of amalgams made from zinc-containing alloys. Similar to the present study, they evaluated leakage after one week and observed corrosion products within the occlusal margins of restorations. Therefore, low leakage scores in the amalgam restorations of the current study can be related to corrosion sealing of the zinc-containing alloy used in the study by Mahler etal.[14]

There was lesser microleakage in EQUIA forte. The advantage of GC EQUIA Forte is an innovative restorative system based on a new glass hybrid technology thathas more voluminous EQFglass fillers supplemented with smaller, highly reactive fillers that reinforce the restoration.The lesser microleakage score of EQUI FORTE as compared to other restorative materials which were used in the study can also be attributed to the very fact that EQUIA forte is a pre-measured capsule of a single component metamorphic material which obviated the uncertainties in the powder / liquid ratio and permitted a uniform mixture of the restored material.EQUIA Forte coat,a composite coating thatimprovesflexural strengthby 17%and flexural power by nearly 30%.EQFCoat penetrates the porosities of the surface and thereforeimproves the strength of the overall EQUIA filling and reducees the microleakage around restoration[15]. In the present study, conditioning of the dentin was carried out in order to remove the smear layer and improve the bonding to the dentin. This could be a contributing factor for the reduced microleakage of EQUI FORTE in the present study. The low viscosity of EQUI FORTE can also reduce the microleakage.

Several manufacturers have introduced “condensable” or “packable” composites as alternatives to amalgam (Leinfelder, 1997; Leinfelder& others 1998).

Packable composites use amalgam techniques to position and create appropriate interproximal contacts (Leinfelder& others, 1998).

Packable composite has demonstrated the highest microleakage in the present study. Resin-based composites placed in conjunction with certain dental adhesives are believed to lose their sealing ability over time, thus permitting microleakage. One of the main drawbacks related to composite restoration or the posterior restorative material is its shrinkage during polymerization which creates stress on the network and its bonding system. This leads to marginal staining, poor marginal seal and recurrent caries, which affects the longevity of the restoration[6].

The long-term effects of the restorative materials in oral environments must be monitored appropriately. Using crosssections helps in a more precise leakage quantification.Stereomicroscope was used for evaluation of prepared samples since it provides well magnified two dimensional images of the tooth sections showing areas of microleakage.

Conclusion

Within the limitations of this study, following conclusions were made.

- Glass hybrid restorative system showed lesser microleakage than resin based restorative material, thereby having better sealing ability.
- However, clinical acceptability of glass hybrid restorative systems has to be verified with larger sample size and with in-vivo studies.

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