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A Comparative Evaluation of Microleakage in Class V Cavity Restored with Three Self Adhering Flowable Composites at Different Time Intervals – An In-Vitro Study.

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Abstract

Aim: To compare and evaluate microleakage in class V restoration restored with three self-adhesive flowable composites at different time intervals.

Method: Seventy – Five extracted human premolars, extracted for orthodontic and periodontal purpose were collected. Wedge-shaped Class V cavity preparation was performed on the buccal surface of each tooth, above the cemento-enamel junction. Cavity preparation of all the sample teeth were done with low-speed handpiece, No.330 bur of width 0.8mm length 1.6mm. After cavity preparations, teeth were subjected to random division into five equal groups (n=15) of group 1 (Constic), group 2 (Dyad flow), group 3 (Fusio liquid dentin), group 4 (Light cured universal restorative glass ionomer cement (GIC) as a positive control) and group 5 (Universal restorative glass ionomer cement as negative control). The teeth samples were sectioned off horizontally 1mm beneath the cemento- enamel junction with a double ended diamond disc bur which was attached to a slow speed micromotor handpiece. For microleakage testing, the teeth samples were sealed with modelling wax. The entire surface of each tooth was covered with nail varnish, leaving restoration uncovered. The teeth samples were then evaluated for microleakage in fluid filtration system. Descriptive statistics was explored in terms of mean and standard deviation. Intragroup, intergroup and multiple group comparison was done with Kruskal Wallis, Mann Whitney U test and ANOVA followed by post hoc test. All the statistical analysis was performed using SPSS version 26.0. pls restructure methods

Results: All groups showed similar microleakage compared to GIC (Control Group). Constic showed gradual increase in microleakage with increase in time interval. Highest microleakage was observed at 6 months interval. Dyad Flow showed steady rise in microleakage in 1month and 2-months interval but showed more microleakage after 4months. Dyad flow showed increase in microleakage after 4-month interval. Fusio Liquid Dentin showed steady rise in microleakage in 1month and 2 months interval but showed more microleakage after 4months interval. It was observed that Group 1 (Constic) showed least microleakage compared to other two self-adhering flowable composites at 4month and 6-month interval, followed by Group 2 (Dyad Flow) and group 3 (Fusio Liquid Dentin) which showed similar microleakage.

Conclusion: It was concluded that there was a significant difference in the microleakage of three self-adhering flowable composites at different time intervals. Make more clinically oriented.

Keywords: composite, fluid filtration system, glass ionomer cement, microleakage.

Introduction

Marginal seal is one of the most significant aspects of a restoration's success.[1] One of the goals of restorative dentistry is to create a biocompatible restoration that maintains a proper marginal seal without damaging the pulp.[2]

Microleakage is the clinically undetectable passage of bacteria, fluids, molecules, or ions in micro gaps (10^{-6} μm) between a cavity wall and the restorative material applied to it. [1] Microleakage is still a key problem, and the primary reason for failure of composite resin restorations. [3] It is the primary cause of restoration margin deterioration, which results in postoperative tooth hypersensitivity, secondary caries, pulpal irritation, pulp necrosis, and restoration marginal discoloration. Microleakage can be caused by occlusal stresses, temperature changes, and differences in the physical qualities of teeth and restorative materials.[4]

Cervical lesions are frequently caused by improper tooth brushing and dental caries, and have little or no enamel at the cervical edge.[5] Tensile and shear stresses generated in the cervical region of the teeth cause cuspal flexure, disrupting the bonds between hydroxyapatite crystals in the tooth, resulting in crack formation, and when combined with the difficulty of obtaining a moisture-free environment, cervical lesions are linked to an increased incidence of microleakage.[2]

Restorative material must be carefully placed in Class V cavities, especially at the cervical wall where only dentin is present.[1] Restoring carious or non-carious lesions in the cervical area is still considered challenging in the dental clinics.[6]

Adequate adhesion between hard dental tissues and restorative materials is critical for optimal clinical performance and long-lasting restoration.[3] Finding a material with adequate bonding characteristics that reduce marginal microleakage has therefore always. been a topic of research.[4]

Glass ionomer cements, resin modified glass ionomer cement (RMGIC), compomers, and resin composites are currently the materials of choice for restoring cervical lesions.[2]

Most direct restorative composite materials have a putty-like viscosity, which is desirable in clinical conditions, but there is a need for a less viscous composite resin for better adaptability with the cavity wall. As a result, in late 1996, a new class of "flowable composite resins" was introduced. Filler loading in flowable resin-based composites is lowered to 37 percent -53 percent (volume), compared to 50 percent -70 percent (volume) in conventional composites. The viscosity of these flowable materials is changed as a result of the different filler loading.[7]

Flowable composite resins are widely used in clinical practice. They are most commonly recommended resin materials for restoring these lesions instead of conventional resin composites. These materials have good aesthetic properties, and due to their low viscosity, are easier to place and more self-adaptable compared to stiffer restorative materials.[5]

One of the recent advances in dentistry is the introduction of self-adhering flowable composite resins which are a product of combining an all-in-one bonding system and flowable composite resin. [9] Self -adhering flowable composite (SAFC) combines the merits of both adhesive and restorative materials in a single product, bringing new horizons, to restorative procedures, as it is a direct composite resin restorative material that has an adhesive resin together with a flowable composite resin. SAFC provides the less chair time, allows fewer steps, provides less chance for errors, and shorter treatment sessions for patients with multiple restorations accomplished within the same visit, this is of great importance, especially for uncooperative or mutilated patients.[11]

Microleakage should be measured using a method that allows for the detection of micro voids as well as the preservation of samples. Microleakage has long been measured using the fluid filtering method. This method has several advantages over other methods: samples are not destroyed, microleakage can be evaluated over time, operators bias can be evaluated, and most importantly, the results are accurate because just a small volume is recorded. Though fluid filtration method is technique sensitive, it is considered to be one of the ideal method for assessment of microleakage.[15]

Thermocycling must be used to evaluate microleakage in order to simulate intraoral conditions. Thermocycling is an in vitro method that involves exposing a restoration and a tooth to temperature fluctuations similar to those encountered in the mouth. [16]

The available self-adhering flowable composites have limited information on their microleakage properties in literature. The aim of this study was to evaluate microleakage of Self-adhering Flowable Composites in comparison with glass ionomer cement.

Materials and method

Method of data collection: A total of Seventy – Five extracted human premolars, extracted for orthodontic and periodontal purpose were collected from the Department of Oral and Maxillofacial Surgery with informed consent of the donor. Teeth were verified for absence of cracks, defects and dental caries. All the teeth were cleaned, removing all debris, attached tissues using ultrasonic scaler. Teeth were stored in distilled water until use.

Sample size: Sample size was calculated using G* Power 3.0.10. The error was set at 5% (0.5) and the power of study (1 – β) was set at 80% (0.8) The sample size was determined to be 15 per group (n = 15). Study was conducted on 75 human extracted premolars.

Study population: This in vitro study was conducted to evaluate microleakage in class V cavity restored with three self-adhering flowable composites at different time intervals.

Study protocol

Preparation of the cavities: Seventy – five non-carious human premolars, extracted for orthodontic and periodontal reasons, were utilized in this study. Before any treatment, teeth were cleaned, explored, debrided and stored in distilled water until use. Wedge-shaped Class V cavity preparation was performed on the buccal surface of each tooth, above the cemento-enamel junction. Cavity preparation of all the sample teeth were done with low-speed handpiece, No.330 bur of width 0.8mm length 1.6mm. For the purpose of standardization, a stainless- steel matrix band, with a window simulating the desired prepared cavity in width and length, was used in order for all cavity preparations to have uniform dimensions of 3 mm occluso-gingival height and 3 mm mesiodistal width. Finally, the depth was set at 1.5 mm, and this was checked in each cavity using a calibrated periodontal probe.

Grouping of the specimens: After cavity preparations, teeth were subjected to random division into five equal groups (n=15) according to the tested materials.

A) Group 1: Constic (Dmg, Germany) (n = 15)

Constic, Self-adhering flowable composite was dispensed with the aid of Luer-Lock™ syringe and it was agitated for 25secs, followed by light curing for 20 secs. The material was layered in increments to prepare the discs of 3x3x1.5mm **as shown in figure A below**

Figure A: Constic Self Adhering Flowable Composite (Dmg, Germany)

B) Group 2: Dyad flow (Kerr) (n = 15)

Dyad Flow, Self-adhering flowable composite was dispensed with the aid of Luer-Lock™ syringe and it was agitated for 25secs, followed by light curing for 20 secs. The material was layered in increments to prepare the discs of 3x3x1.5mm **as shown in figure B below**

Figure B: Dyad Flow Self Adhering Flowable Composite (Kerr, Orange, CA, USA)

C) Group 3: Fusio liquid dentin (Pentron) (n = 15)

Fusio Liquid Dentin, Self-adhering flowable composite was dispensed with the aid of Luer-Lock™ syringe and it was agitated for 25secs, followed by light curing for 20 secs. The material was layered in increments of to prepare the discs of 3x3x1.5mm **as shown in figure C below.**

Figure C: Fusio Liquid Dentin Self Adhering Flowable Composite (Pentron, Usa)

D) Group 4: (positive control) Light cured universal restorative glass ionomer cement (Gc gold label) (n = 15)

After cavity preparation, cavity walls were etched with 37% Phosphoric acid etchant gel for 15 secs followed by a thorough rinse with water. Light Cured Restorative Glass Ionomer Cement was placed in the cavity and light cured for40 secs.

Group 5: (negative control) **Universal restorative glass ionomer cement (Gc gold label) (n = 15)**

After cavity preparation, cavity walls were conditioned with polyacrylic acid for 5 sec. After conditioning and rinsing, cavity surface was dried. Glass ionomer cement was then placed in the cavity.

To simulate the aging of material, each of the 5 groups including 75 samples were subjected to thermocycling according to the following protocol: 1 month, 2 months, 4 months, and 6 months of storage in distilled water. All specimens were subjected to microleakage test through fluid filtration device.

Specimens were subjected to Thermocycling for 1000 cycles between 5^0 and 55^0C with a dwell time of 10 secs in each bath and a transfer time of 5 secs **as shown in figure D below.**

Figure D: Thermocycler meter (Eppendorf India Pvt Ltd, Ambattur, Chennai

Sectioning of Specimens: The teeth samples were sectioned off horizontally 1mm beneath the cemento-enamel junction with a double ended diamond disc bur which was attached to a slow speed micromotor handpiece.

Microleakage assessment : After restoration of the cavities, each group was subjected to microleakage assessment in fluid filtration device **as shown in figure E below**.

Figure E: Fluid Filtration Device (From left to right oxygen cylinder, pressurized buffer system, latex pipe, micropipette, three-way bilateral control faucet, syringe andtooth sample)

For microleakage testing, the teeth samples were sealed with modelling wax. The entire surface of each tooth was covered with nail varnish, leaving restoration uncovered. The teeth samples were then evaluated for microleakage in fluid filtration system **as shown in figure F below.**

Figure F: Prepared samples

Statistical Analysis

All the data was entered in Microsoft excel sheet. Data normality was explored using Shapiro wilk test. Descriptive data was explored using mean and standard deviation. Intergroup comparison was done by Mann

Whitney U test followed by ANOVA with post hoc Bonferroni test. The statistical significance was kept at P<0.05. All the data analysis was done through SPSS version 26.0.

Results

Intergroup comparison was done to assess significant difference between the mean value of microleakage of different groups using Kruskall Wallis ANOVA followed by Mann Whitney U test to assess pair wise comparison. All statistical tests were performed at 95% confidence intervals; keeping p value of less than 0.05 as statistically significant.

Table 1: shows the descriptive statistics at the 1 month, 2 months, 4 months and 6 months.

		N	Mean	Std. Deviation	Std. Error	Chi squarevalue	P value of Kruskal- Wallis Test
1month	1	15	-5.93888	.015860	.005015	45.664	.000
	2	15	-6.52183	.000647	.000205		
	3	15	-6.39696	.000343	.000108		
	4	15	-6.39424	.003246	.001026		
	5	15	-6.22102	.000540	.000171		
	Total	75	-6.29459	.204153	.028872		
	1	15	-6.23991	.015860	.005015	45.664	.000
	2	15	-6.82286	.000647	.000205		
	3	15	-6.69799	.000343	.000108		
	4	15	-6.69527	.003246	.001026		
	5	15	-6.52205	.000540	.000171		
	Total	75	-6.59562	.204153	.028872		
4months	1	15	-6.54094	.015860	.005015	45.664	.000
	2	15	-7.12389	.000647	.000205		
	3	15	-6.99902	.000343	.000108		
	4	15	-6.99630	.003246	.001026		
	5	15	-6.82308	.000540	.000171		
	Total	75	-6.89665	.204153	.028872		
6months	1	15	-7.12389	.000647	.000205	45.007	.000
	2	15	-6.99902	.000343	.000108		
	3	15	-6.99630	.003246	.001026		
	4	15	-6.82308	.000540	.000171		
	5	15	-6.84197	.015860	.005015		
	Total	75	-6.95685	.112998	.015980		

Intergroup comparison was done to assess significant differences between the mean values of different groups at the end of 1 month, 2 months, 4 months and 6 months using Kruskal Wallis ANOVA. This comparison showed statistically highly significant difference seen for the values between the groups ($p<0.01$).

A) Inter Group comparison

Inter group pair wise comparison using Mann-Whitney U test was done to assess significant difference between Group 1,2,3 and 4 after time interval of 1 month, 2 months, 4 months and 6 months There was a statistically highly significant / significant difference seen for the values ($p<0.01$, 0.05) on all time intervals **as shown in figure G**

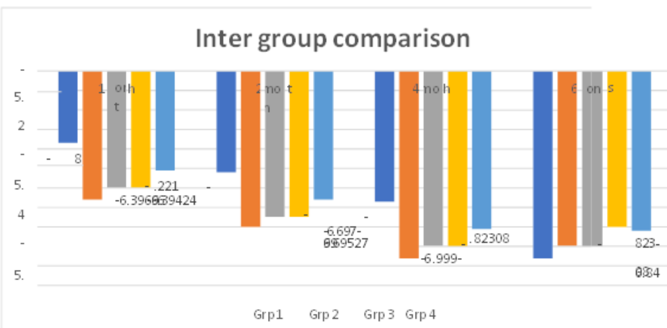

Figure G: Intergroup Comparison of Values At 1 Month, 2 Month, 4 Month,6 Month Interval

A) Intra-Group Comparison- as shown in figure H

Group 1 - There was a statistically significant difference seen for the values between the time intervals ($p<0.01$) with higher magnitude at 6 months

Group 2 - There was a statistically highly significant difference seen for the values between the time intervals ($p<0.01$) with higher values at 6 months

Group 3 - There was a statistically highly significant difference seen for the values between the time intervals ($p<0.01$) with higher values at 6 months

Group 4 - There was a statistically highly significant difference seen for the values between the time intervals ($p<0.01$) with higher values at 6 months

Group 5 - There was a statistically highly significant difference seen for the values between the time intervals ($p<0.01$) with higher values at 6 months

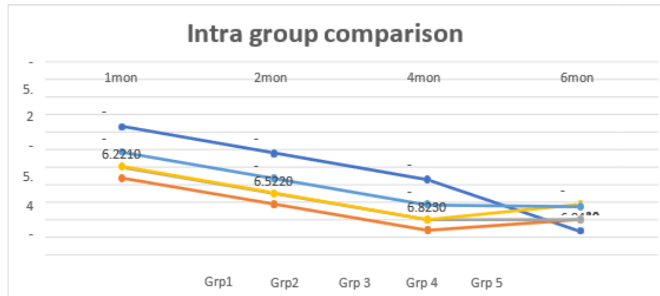

Figure H: Intragroup Comparison of Values At 1 Month, 2 Month, 4 Month,6 Month Interval

B) Intra Group Pair Wise Comparison

Pair wise comparison using Wilcoxon Signed Ranks Test, paired four different time intervals of 1, 2, 4 and 6 months as 1 month with 2 months, 1 month with 4 months, 1 month with 6 months, 2 months with 4 months, 2 months with 6 months and 4 months with 6 months.

Group 1 - There was a statistically highly significant difference seen for the values between all the pairs of time intervals ($p<0.01$)

Group 2 - There was a statistically highly significant difference seen for the values between all the pairs of time intervals ($p<0.01$)

Group 3 - There was a statistically highly significant difference seen for the values between all the pairs of time intervals ($p<0.01$)

Group 4 - There was a statistically highly significant difference seen for the values between all the pairs of time intervals ($p<0.01$)

Group 5 - There was a statistically highly significant difference seen for the values between all the pairs of time intervals ($p<0.01$)

Discussion

This study compared and evaluated microleakage of three different self-adhering flowable composites in Class V cavity using Fluid Filtration Method. In vitro procedures are used to assess leakage rather than in vivo approaches, which can be qualitative and quantitative.

For any restorative method to preserve pulpal health and improve the restoration's longevity, the marginal seal's integrity and durability are critical.[17] Modern adhesive dentistry aims to reduce microleakage by enhancing the marginal adaptation of dental restoration.[18]

Microleakage is one of the poor links with composite resin restorations, contributing to postoperative vulnerability and a high incidence of secondary caries, which accounts for many clinically failed restorations. Bacteria, their metabolites, enzymes, toxins, ions, and other cariogenic substances enter between the filling and the cavity wall in clinically undetectable levels, resulting in marginal microleakage.[19]

Several methods have been used to assess the degree of microleakage and the reliability of restorations alongside the margins. It is advisable to measure microleakage with a method that allows the detection of micro voids along with the preservation of samples.[20] Fluid filtration system method has several advantages over the commonly used methods: the samples are not destroyed, permits the evaluation of microleakage over time, operators bias and most importantly the results are accurate since very small volume is recorded. Though fluid filtration method is technique sensitive, it is considered to be one of the ideal methods for assessment of microleakage.[15]

Shaikh A, Hegde V, Shanmugasundaram S, Dixit V (2017)[15] conducted a study on a novel approach to construction and working of fluid filtration model: An experimental study. The authors concluded that this model can be used for the evaluation of microleakage of dental materials.

In the present study, non-carious Class V adhesive restorations were chosen for testing, given that they have been considered ideal for assessing bonding effectiveness for several reasons.[21] Clinical effectiveness of adhesives should best be determined using Class-V clinical trials, Because (1) such lesions do not provide any macro-mechanical retention, so that ineffective bonding will result in early restoration loss, (2) Class-V restoration margins are located in enamel as well as in dentin, (3) lesions are commonly located on vestibular surfaces of anterior teeth and premolars, thus providing good access for the restorative procedure as well as evaluation (visually using an explorer and magnifying glasses), (4) preparation and restoration of Class-V lesions is minimal and relatively easy, thereby reducing technique-sensitivity and operator-related variability. (5) lesions are relatively wide spread and prevail on multiple teeth, facilitating patient selection and enabling split-mouth study designs, and (6) Class-V lesions have a relatively small C- factor, by which the mechanical properties of the composite resin used are less influential, and the bonding potential of the adhesive determines the outcome of the restoration to a greater extent.[22]

Microleakage was assessed by the fluid filtration technique. This system involves the assessment of fluid movement in the model calculated through bubble displacement. It is essential to apply pressure to fluid for the displacement of bubble.[23] The system as shown in the Figure consists of two sections: SECTION A: Consists of the tubes, pipes, syringes, micropipette, control faucet, buffer system (Borosil co.) and the tooth sample SECTION B: Consists of the recorder of the bubble displacement which includes digital SLR camera (Canon1200D) AutoCAD (Autodesk, Inc.)

A micropipette of 0.1cc (Borosil Co.) was used in this study as smaller the diameter, more accurate is the measurement. A bubble of the same size of the internal diameter of the micropipette was introduced.[15]

Aging restorations at body temperature and exposing them to thermocycling and/or mechanical loading are treatment methods commonly used before in vitro microleakage testing to simulate the intraoral service life of a restoration.[24] Different regimens have been used for thermocycling dental restorations with recommended temperatures ranging between 4° and 60° C.[25] In the current study all specimens were subjected to 1000 cycles between 5° C and 55° C with a dwell time of 30 seconds which is considered an appropriate artificial aging test because it is equivalent to 12 months of clinical service.

The adhesive bond between dental restorative materials and adhesive cement is critical for the restoration's longevity and clinical performance.

Therefore, it can be stated that within the limitations of our study, that although all the groups i.e. Constic, Dyad Flow, Fusio Liquid dentin had a statistically significant difference in the microleakage as compared to Glass Ionomer Cement, Group 1 (Constic) showed least microleakage compared to other two self-adhering flowable composites at 4month and 6-month interval, followed by Group 2 (Dyad Flow) and group 3 (Fusio Liquid Dentin) which showed similar microleakage. This signifies that although all the self-adhering flowable composites are effective and efficient one group is more superior in the same.

Further research on this topic with more sample size and comparison with newer materials can be done to assess microleakage.

Conclusion

Within the limitations of this study, it can be concluded that there was a significant difference in the microleakage of three self-adhering flowable composites at different time intervals.

All the groups showed microleakage,

i. Group 1 (Constic) showed less microleakage as compared to all other self- adhering flowable groups.

ii. Group 2 (Dyad Flow) showed more microleakage as compared to Group 1 (Constic), Group 4 (Light cured Glass Ionomer Cement) and Group 5 (Universal Restorative Glass Ionomer Cement), and similar microleakage as compared to Group 3 (Fusio Liquid Dentin)

iii. Group 3 (Fusio Liquid Dentin) showed more microleakage as compared to Group 1 (Constic), Group 4 (Light cured Glass Ionomer Cement) and Group 5 (Universal Restorative Glass Ionomer Cement), and similar microleakage as compared to Group 2 (Dyad Flow)

iv. Group 4 (Light cured Glass Ionomer Cement) showed least microleakage as compared to all other groups.

v. Group 5 (Universal Restorative Glass Ionomer Cement) showed more microleakage as compared to Group 2, Group 3 and Group 4.

vi. On comparison of time intervals i.e. 1month, 2month, 4month, 6month for all the groups, it was observed that with time there was gradual increase inmicroleakage.

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