

Comparative evaluation of microleakage of G-aenial Universal Flo, Smart Dentin Replacement and Tetric Evo Ceram bulk fill resin composite restorations in class v cavity preparation: an in-vitro study

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Abstract

Aim and Objective: Was to assess and compare the microleakage of G-aenial Universal Flo, Smart Dentin Replacement and Tetric Evo Ceram bulk fill resin composites in class V cavities along the occlusal and gingival margins using dye penetration test under stereomicroscope.

Materials and Methods: Seventy five human extracted premolars were selected and randomly divided into 3 groups (n=25), as per the restorative materials for microleakage test. Group I: Tetric Evo Ceram (Bulk fill non flowable). Group II: G-aenial Universal Flo (Highly filled flowable resin composite). Group III: Smart Dentin Replacement (Bulk fill flowable resin composite). Class V (box) cavities were prepared both on the buccal and lingual surfaces of each of the 75 teeth, a total of 150 cavities, restored, immersed in 2% methylene blue dye for 24 hours and then sectioned bucco lingually into two halves. Dye penetration score was measured along occlusal and gingival wall using a Stereomicroscope at 40X magnification. Statistical analysis was done using Chi square test for microleakage assessment. P value was set at <0.05.

Result: Intergroup comparison showed statistically no significant difference between the three groups both occlusal and gingival wall, whereas groupwise comparison showed statistically significant result between group I and Group II at gingival wall with P value 0.021.

Conclusion: None of three resin composite materials were free from microleakage. All the three materials showed more microleakage at gingival wall compared to occlusal wall. Among all the tested groups G-aenial Universal Flo showed the least microleakage at the gingival wall.

Keyword: Microleakage, Class V, Resin composites.

Introduction

Resin composites were introduced in the 1960s, since then constant research and refinements in this field gave expanded options for restorative dentistry. This on-going research leads to the development of newer formulations of resin composites, which includes non flowable, flowable incremental and bulk fill resin composites. These newer resin composites aimed to improve physical and mechanical properties in order to achieve better and promising applications in the field of restorative dentistry.¹

Nevertheless, despite the continuous evaluations in this field, drawbacks such as marginal microleakage and polymerization shrinkage still occur. It is difficult to achieve perfect adaptation to the internal cavity walls and proper marginal seal of the cavity with high viscosity resin composite. Introduction of flowable resin composite, gives an option for better adaptability to cavity walls and their use can reduce marginal defects in restorations.²

Flowable composites are low-viscosity resin composites obtained from formulations with 20-25% lower filler loading and increased resin content than conventional resins. The reduced viscosity of the mixture makes its placement possible by injection syringes and also limits stickiness. Therefore flowable

restorative resins are recommended as the material of choice for restoring class V cavities.³

Flowable resins showed higher polymerization shrinkage and have inferior mechanical properties due to its lower filler content. Although the first generation flowable resin composites were used only as liners due to low elastic modulus, second generation flowable resin composites were developed for use in bulk restorations and as liners in class I and II restorations.⁴

Polymerization shrinkage is the major disadvantage of resin composite; this can result in the failure of marginal adaptation between the tooth structure and resin composite. It occurs more commonly when the margins of the restoration are placed at dentin or cementum.

Microleakage is a phenomenon in which oral micro-organisms, fluids and chemical substances are diffused through the interface between tooth structure and restorative material. Despite the continuous efforts to improve physical and mechanical properties, and the operating techniques with resin composites, problems such as polymerization shrinkage and marginal microleakage still causes significant reluctance in using them.⁵ Flowable resin composites such as Smart Dentin Replacement (SDR) contains polymerization modulators which reduce polymerization shrinkage

stress. Koyuturk et al reported successful results when the microleakage with SDR restoration was compared with posterior resin composites.⁷

Tetric Evo Ceram bulk fill is a non flowable bulk fill resin composite (increments of upto 4 mm to be polymerized in 10 seconds) with a patented light initiator Iovocerin, which is the decisive advantage of this sculptable product.¹⁰ Recently introduced highly filled flowable G-aenial Universal Flo claims that it can be used as a direct restorative material for Class I, II, III, IV and V cavities.⁹

To the best of our knowledge, there are few studies regarding the degree of microleakage of newly introduced resin composite G-aenial Universal Flo (GUF), Smart Dentin Replacement (SDR) and Tetric Evo Ceram bulk fill (TEC) to prove the marginal sealing ability when used as direct posterior restorative materials.^{4, 5,10-12,15}

Hence the purpose of this study was to evaluate the microleakage of flowable resin composites G-aenial Universal Flo, Smart Dentin Replacement and non flowable resin composite Tetric Evo Ceram bulk fill in class V cavity preparations.

Materials and Methods

Ethical clearance was obtained from Institutional Ethical Committee (IEC) to conduct study. The study was conducted on extracted human premolar teeth which fulfill the inclusion criteria. The extracted teeth obtained were immediately stored at room temperature in deionized water to which 1% thymol was added, taking care not to let them dry. The stored teeth were cleaned with ultrasonic scaler to remove the surface deposits.

Preparation of the specimens: Class V (box) cavities were prepared both on the buccal and lingual surfaces of 75 teeth, with a total of 150 cavities. The gingival cavosurface margin of the preparation was approximately 1.5 mm below the cemento-enamel junction and occlusal margin was approximately 1.5 mm above the cemento-enamel junction. The preparations were made with a No. 245 carbide bur (SS White) in a high speed standardized handpiece under copious water coolant. The dimension of the final cavity preparation was approximately 3.0 mm Occlusogingivally, 3.0 mm mesiodistally and 2 mm deep.

The preparations were etched with 37% phosphoric acid (Scotch bond Etchant, 3M ESPE) for 20 seconds, rinsed with water for 15 seconds and blot dried, leaving the dentin moist and shiny. An ethanol and water based adhesive system (ADPER single bond 2, 3M ESPE) was applied in two consecutive coats to the entire preparation, after 10 seconds of application gently air dried for 5 seconds and light cured for 20 seconds. Teeth were randomly divided into the three groups of

25 each corresponding to three different resin composites.

Group I: Tetric Evo Ceram (Bulk fill non flowable), Group II: G-aenial Universal Flo (Highly filled flowable resin composite) and Group III: Smart Dentin Replacement (Bulk fill flowable resin composite). The specimens in each group were restored with the corresponding resin composite according to manufacturer's instructions. The restored specimens were stored in distilled water at 37°C for 12 hours. The restorations were then finished and polished with aluminum oxide disks (Sof-Lex Pop On, 3M ESPE). The teeth were coated with two layers of nail varnish leaving approximately 1.0 mm width around the restoration, to allow the contact of the tracing agent with the margin of the restoration. The specimens were thermocycled for 1000 cycles at 5°C and 55°C with 30 seconds of dwell time. The specimens were immediately immersed in 2% Methylene blue dye for 24 hours. The specimens sectioned through bucco lingual direction with a sectioning disc. Then the restorations were analyzed with a stereomicroscope at 40x magnification and scored for degree of dye penetration along the occlusal and gingival walls: The scores given were as follows. Scores: 0= No Dye penetration., 1= Dye penetration short of dentino-enamel junction (DEJ)/ cemento-dentinal junction (CDJ)., 2= Dye penetration up to DEJ/ cemento-dentinal junction (CDJ)., 3=Dye penetration beyond DEJ/ cemento - dentinal junction (CDJ)., 4=Dye penetration till/into the axial walls.

Results

Group allocation, manufactures information and chemical composition of each materials are given in Table 1, Table 2: Shows the intergroup comparison for microleakage along the occlusal wall using Chi square test and there is no statistically significant difference between the groups with the P value 0.583. Table 3: Shows the intergroup comparison for microleakage along the gingival wall using Chi square test and there is no statistically significant difference between the groups with the P value 0.583. Table 4: Shows group wise comparison for microleakage along the occlusal and gingival wall. There is statistically significant difference between group I and group II along gingival wall with P value 0.021, Group II exhibiting less microleakage than Group I. Group II vs Group III as well as Group I vs Group III shows no statistically significant differences.

Table 1: Group allocation, manufactures information and chemical composition of each material

Groups	Type and Manufacture	Matrix system	Filler system
Group I Tetric Evo Ceram bulk fill (TEC),	Bulk fill non flowable Ivoclar Vivadent	Bis GMA, UDMA	Barium glass, Ytterium trifluoride, mixed oxide and prepolymer
Group II G-aenial Universal Flo (GUF),	Highly filled flowable, incremental GC India	UDMA, Bis-MEPP, TEGDMA	Silica, Strontium glass.
Group III Smart Dentin Replacement (SDR),	Bulk fill flowable Dentsply Caulk	Modified UDMA, EBPDMA, TEGDMA.	Barium aluminofluoride, borosilicate glass

Table 2: Shows intergroup comparison of microleakage along occlusal wall

Groups	Occlusal wall dye penetration (%)						Chi square value	P value
	0	1	2	3	4	Total		
Group I	2 (8)	0 (0)	1 (4)	14 (56)	8 (32)	25 (100)	4.700	0.583 (N.S)
Group II	6 (24)	0 (0)	0(0)	14 (56)	5 (20)	25 (100)		
Group III	4 (16)	0(0)	0(0)	14 (56)	7 (28)	25 (100)		

Table 3: Shows intergroup comparison of microleakage along gingival wall

Groups	Gingival wall dye penetration (%)						Chi square value	P value
	0	1	2	3	4	Total		
Group I	0 (0)	0 (0)	0 (0)	11 (44)	14 (56)	25 (100)	4.700	0.583 (N.S)
Group II	0 (0)	0 (0)	0 (0)	19 (76)	6 (24)	25 (100)		
Group III	0(0)	0(0)	0(0)	14 (56)	11 (44)	25 (100)		

Table 4: Shows group-wise comparison of microleakage along occlusal and gingival wall

		Chi Square value	P value
Group I and II	Occlusal	3.692	0.297 (N.S)
	Gingival	5.333	0.021 (S)
Group II and III	Occlusal	0.733	0.693 (N.S)
	Gingival	2.228	0.116 (N.S)
Group I and III	Occlusal	1.733	0.630 (N.S)
	Gingival	0.720	0.286 (N.S)

Discussion

The longevity of resin based composite depends on the interfacial bonding between resin and cavity walls, which should prevent the marginal microleakage that causes staining at the margins of restorations, recurrent caries, hyper sensitivity and pulp pathology.⁴²

Microleakage is an important property used to assess the success of restorative material, which is described as chemically undetectable passage of bacteria, fluids, molecules or ions between the cavity walls and restorative materials.³⁰ The possible reasons attributed to microleakage in enamel and dentin

restoration margins are polymerization shrinkage, physical characteristics of the restorative material, inadequate marginal adaptation of the restorative material, curing light source – photoinitiators etc. Restoring class V cavity is challenging because most of the cervical margins of these lesions are located in dentin and /or cementum, leading to a weaker marginal adaptation than that of enamel surface, which eventually leads to failure of the restoration.¹² Many attempts have been made to improve the resin composites, to increase their usefulness; however polymerization shrinkage continues to remain one of

the primary deficiencies of the composite restoration, which causes the microleakage at margins of the restorations.^{33,34,37,46}

Thermocycling was done in this study because it is a widely used method in dental research, particularly when testing the performance of adhesive material. It aims at thermally stressing the adhesive joint at the tooth / restoration interface by subjecting the restored teeth to extreme temperatures encountered intraorally. This process may highlight the mismatch in thermal expansion between the restoration and tooth structure, resulting in different volumetric changes during temperature changes and causing fatigue of the adhesive joint with subsequent microleakage.^{12,16,20,21,25,29}

In this present study, Tetric Evo Ceram (group I) showed highest microleakage scores followed by Smart Dentin Replacement (group III) and G-aenial Universal Flo (group II) in the occlusal wall. The possible reason could be: a) Higher viscosity of Tetric Evo Cerambulk fill – it won't flow properly in to the cavity wall like flowable resin composites, which may lead to marginal discrepancies and subsequent microleakage.¹¹ b) Elastic modulus of Tetric Evo Ceram is high when comparing with flowable resin composites.¹¹

When comparing group I and group III, Smart Dentin Replacement (group III) showed less microleakage than group I. This was in accordance with the previous study done by Miroslaw O el al in 2014.¹¹ The possible reasons could be: a) Smart Dentin Replacement is based on a patented stress decreasing technology, which results in low shrinkage stress rate and better cavity wall adaptation.⁷ b) Lower modulus of elasticity - which helps the material to withstand masticatory loads and also helps to reduce the marginal gap formation of the tooth restorative interface.⁴² c) Flow consistency during application, Peutzfeldt and Asmussen et al, showed that the increased fluidity of composite resin makes it to adhere better to the cavity wall.⁴²

In this present study 6 specimens of G-aenial Universal Flo (group II), 4 specimens of Smart Dentin Replacement (group III) and in Tetric Evo Ceram (group I) 2 specimens, did not show microleakage in occlusal wall, though there was no statistically significant difference observed between the groups. This was in accordance with the previous study done by Sujatha G S et al in 2014.¹² When comparing group I and group II in the gingival wall, group II showed least microleakage with statistically significant difference. When comparing group II group III, group II showed less microleakage both occlusal and gingival wall, though there is no statistically significant difference was found between the groups.

All the groups showed microleakage at the gingival wall, but group II showed less microleakage than group III and group I. The possible reasons for less microleakage could be due to: a) G-aenial Universal

Flo contains a new silane surface treated ultra-fine strontium glass fillers with an average 200 nm size, provides improved bonding between the particle and matrix, thereby minimizing the polymerisation shrinkage.⁹ b) High flexibility- G-aenial Universal Flo has lower modulus of elasticity which helps the material to withstand masticatory forces and also helps to reduce the marginal discrepancies of the tooth restorative interface.⁹ c) Low volumetric shrinkage- helping to conserve tooth structure by preserving the margins there by minimizing the microleakage and cracks.⁹ d) The viscosity of G-aenial Universal Flo is lower than that of Smart Dentin Replacement and Tetric Evo Ceram and behaves more like a restorative material; this improved handling properties best suits for the cervical cavities.^{9,12} statistically significant difference was found in microleakage between group II & group III and between group I& group III. The results obtained in this study showed that all the three groups exhibited more microleakage in the gingival wall than on occlusal wall .This was in accordance with previous studies done by Nayak et al. and Kumar Gupta et al.^{47,48}

Thermocycling is often employed in the laboratory experiments to simulate stresses in the oral cavity however the absence of outward flow of the dentinal fluid and the completely altered dentinal surface due to extraction can lead to a poor correlation between in vitro and in vivo conditions. In this study Adper single bond II was used as a bonding agent for all the groups which may have influenced the marginal gap formation.^{11,43,44} However the validity of this in vitro study could be appreciated through further clinical trials.

Conclusion

Within the limitations of the study,

1. None of three resin composite materials tested were free from microleakage.
2. All the three materials showed more microleakage at gingival wall compared to occlusal wall.
3. G-aenial Universal Flo showed the least microleakage at both occlusal and gingival walls.

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