10.5005/jp-journals-10051-0094

ORIGINAL RESEARCH

Comparative Evaluation of Marginal Leakage around Cavities restored with Novel Self-adhesive Flowable Composite Resin and Conventional Total Etch-based Resin

[1]Sahadev C Krishnegowda, [2]Bharath M Jaganath, [3]Sandeep Rudranaik, [4]Nisha B Kurup, [5]Sajin Madanan, [6]CG Manjula

ABSTRACT

Introduction: The advent of self-adhesive composite resin restorative material is one of the greatest improvisations among composite resin restorative materials. The currently available self-adhesive materials are marketed to be used for preparations like small class I and II cavities, liner under large restorations, as pit and fissure sealants, and for repair of porcelain crowns. Their low viscosity and ease of placement would make them ideal for restoration of small class V cavities.

Aim: The aim of the study was to evaluate the marginal integrity of self-adhesive flowable composite resins when compared with conventional total etch composite resins.

Materials and methods: Twenty intact noncarious human premolars extracted for orthodontic reasons were selected for the study. Class V cavities were prepared with margins in enamel with dimensions 2 mm occlusogingivally, 3 mm width, and 2 mm depth. Two groups of 10 teeth each were selected—group I: Restored with self-adhesive flowable composite resin Dyad Flow (Kerr) and group II: Restored with conventional total etch system Filtek Z350XT (3M ESPE) flowable resin composite. All 20 teeth were immersed in methylene blue dye for 24 hours. Samples were washed, sectioned buccolingually, and viewed under stereomicroscope for dye penetration. The data were subjected to Mann–Whitney U test ($p < 0.001$) and chi-squared test ($p < 0.001$).

Results: The samples restored with Dyad Flow presented no dye leakage.

Conclusion: The self-adhesive flowable composite has superior marginal adaptability when compared with total etch-based resin system.

Keywords: Flowable composite, Marginal adaptation, Self-adhesive composite.

How to cite this article: Krishnegowda SC, Jaganath BM, Rudranaik S, Kurup NB, Madanan S, Manjula CG. Comparative Evaluation of Marginal Leakage around Cavities restored with Novel Self-adhesive Flowable Composite Resin and Conventional Total Etch-based Resin. Int J Oral Care Res 2017;5(3):187-190.

Source of support: Nil

Conflict of interest: None

[1]Professor and Head, [2]Professor, [3]Reader, [4-6]Postgraduate Student

[1-3,5,6]Department of Conservative Dentistry and Endodontics, Sri Hasanamba Dental College, Sri Hasanamba Dental College & Hospital, Hassan Karnataka, India

[4]Department of Conservative Dentistry and Endodontics, Sri Hasanamba Dental College & Hospital, Hassan, Karnataka India

Corresponding Author: Nisha B Kurup, Postgraduate Student Department of Conservative Dentistry and Endodontics, Sri Hasanamba Dental College & Hospital, Hassan, Karnataka India, Phone: +918971805308, e-mail: nishaharik@gmail.com

INTRODUCTION

Restorative dentistry is constantly evolving. The need for better esthetics led to various changes in the original composite resin as introduced by Bowen in the early 1960s. The evolution of composite resins attained newer heights with the advent of self-adhesive composite resin technology. Though the etch-and-rinse adhesive approach devised by Buonocore is still the preferred method, self-adhesive resins allow a simpler, less time consuming, and less technique-sensitive clinical procedure.

Microleakage around restorations has always been a major concern in restorative dentistry. It may be defined as the clinically undetectable passage of bacteria, fluids, molecules, or ions between a cavity wall and the restorative material applied to it.[1] This may affect the longevity of restorations by leading to discoloration, recurrent caries, and pulpal pathology.

Flowable composites are convenient to use owing to their low viscosity, ease of handling, and less technique sensitivity. Dyad Flow™ (Kerr, Orange, CA, USA) is a self-adhesive flowable composite resin. In contrast to total etch systems, Dyad Flow eliminates the need for conventional etching and bonding steps. The material is said to adhere to the tooth surface by micromechanical and chemical interactions. This is achieved by inclusion of acidic adhesive monomers into the flowable resin composite.

The aim of this study was to compare the microleakage around class V cavities restored with conventional total etch-based flowable composite resin Filtek Z350 XT (3M ESPE, St Paul, MN, USA) and self-adhesive composite Dyad Flow™ (Kerr, Orange, CA, USA).

MATERIALS AND METHODS

Standard methodology was selected from previous studies, and slight modifications were made according

Table 1: Materials used and protocol

Material	*Batch #*	*Composition*	*Protocol*
Dyad Flow self-adhesive composite resin Shade A3 (Kerr, Orange, CA, USA)	5394153 Expiry 2016-11	GPDM, prepolymerized filler, 1-μm barium glass filler, nanosized ytterbium fluoride	Air dry the cavity; application of <0.5 mm layer; Brushing for 10 sec; Light curing for 20 sec (40 sec for opaquer shades)
Scotchbond™ Multipurpose Etchant (3M ESPE, St Paul, MN, USA)	N637118 Expiry 2017-10	Phosphoric acid 37% and clorhexidine 2%	Phosphoric acid for 15 sec, wash for 30 sec, dry for 5 sec
Adper™ Single Bond 2	N707978 Expiry 2017-07	Bis-GMA, HEMA, UDMA, dimethacrylates, ethanol, water, camphorquinone, photoinitiators, copolymer of polyalkenoic acid, silica (5 nm)	Apply the adhesive, gentle air 5 sec, VLC 10 sec
Filtek™ Z350 XT VLC flowable nanocomposite Shade A3 (3M ESPE, St Paul, MN, USA)	N693617 Expiry 2017-05	Bis-GMA, TEGDMA, Bis-EMA, silane-treated ceramic, silica, zirconium oxide—55 vol%/65 wt%	Apply and VLC 20 sec

Composition as provided by respective manufacturer: Bis-GMA, bisphenol glycidyl dimethacrylate; HEMA: 2-hydroxyethyl methacrylate; TEGDMA: triethylene glycol dimethacrylate; Bis-EMA: bisphenol A polyethylene glycol dimethacrylate; VLC: Visible light curing

to the needs of our study.[1-19] Twenty freshly extracted noncarious human premolars were collected for the study. The teeth were stored in 0.2% thymol solution until use. The exclusion criteria included teeth with fracture lines and cracks.

Standard class V cavities were prepared on the buccal surface of all the 20 premolars with margins fully in enamel. The preparation was done using a cylindrical diamond bur (FG315, Intensive, Grancia, Switzerland) mounted on a high-speed handpiece with copious water coolant. The cavity dimensions were maintained at 3 mm mesiodistal width, 2 mm occlusogingival height, and 2 mm depth.

The teeth were then randomly divided into two groups (n = 10). Group I was assigned for restoration using Dyad Flow self-adhesive flowable composite resin. Group II was assigned for restorations using total etch composite resin Filtek Z350 XT. All the restorations were done according to manufacturers' instructions (Table 1).

All the restored teeth were then stored at 37 ± 2°C in 100% relative humidity for a period of 1 week. No further finishing and polishing were done as flowable resin itself imparts a well-glazed surface characteristic to the restoration. The teeth were covered with nail varnish leaving a 1 mm margin around the restoration margins. The teeth were then immersed in 0.2% methylene blue dye for a period of 24 hours. After 24 hours, the teeth were washed under running water. All teeth were sectioned buccolingually using a diamond disk (Isomet, Buehler, IL, USA) at slow speed, and observations were done under a stereomicroscope (Labomed Inc, Los Angeles, CA, USA). Dye penetration was graded according to Table 2.

Table 2: Scoring Description

Score	*Description*
0	No dye penetration
1	Dye penetration not more than half of the occlusal or gingival wall
2	Dye penetration more than half of the occlusal or gingival wall
3	Dye penetration along axial wall

Table 3: Mean microleakage analysis

Mann–Whitney U test			
Groups	*Mean score*	*Mean rank*	*p-value*
I	0	5.50	<0.001
II	1.4 ± 0.834	15.50	

Table 4: Mean microleakage percentage

Chi-squared test				
	Microleakage score			
Groups	*Score 0*	*Score 1*	*Score 3*	*p-value*
I	10	0	0	<0.001
	100.0%	0.0%	0.0%	
II	0	8	2	
	0.0%	80.0%	20.0%	

The results of the study were statistically analyzed by Mann–Whitney U Test and chi-squared test using Statistical Package for the Social Sciences software (Tables 3 and 4).

RESULTS

Microleakage was assessed as shown in Figures 1 to 3. None of the samples in group I restored with self-adhesive flowable composite presented with dye penetration, whereas all the samples in group II restored with etch-and-rinse flowable composite presented with dye penetration. The Mann–Whitney U test was used to check the difference in mean microleakage score, and chi-squared test was used to check the proportion of samples with different microleakage scores. The mean microleakage scores were statistically significantly lower in group I ($p < 0.001$).

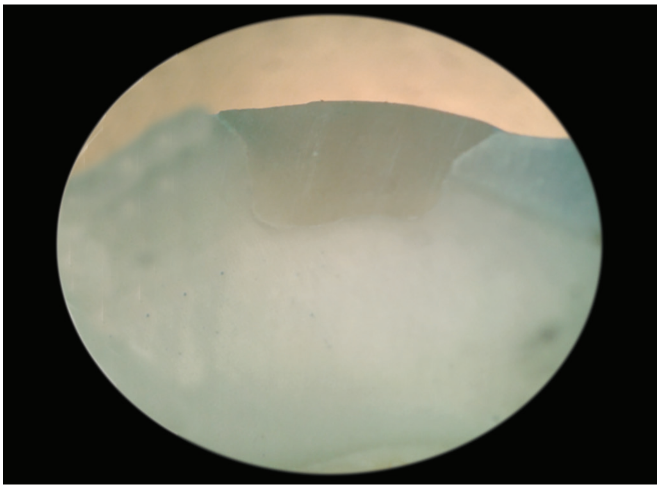

Fig. 1: Image presenting no dye penetration in self-adhesive flowable composite (score 0)

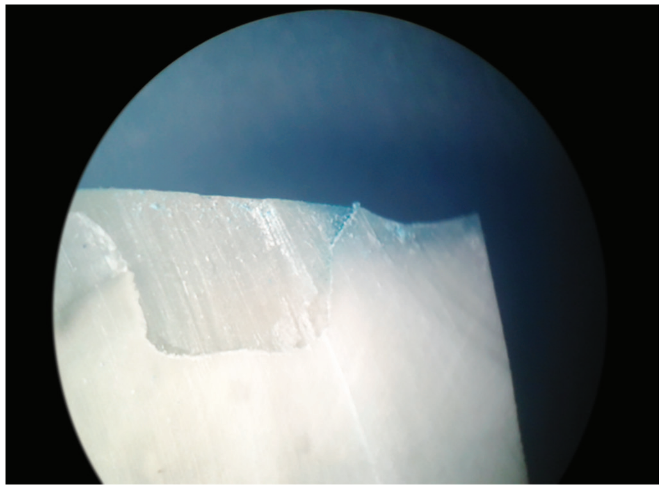

Fig. 2: Image presenting dye penetration up to two-thirds of occlusal or gingival wall in etch-and-rinse flowable composite (score 2)

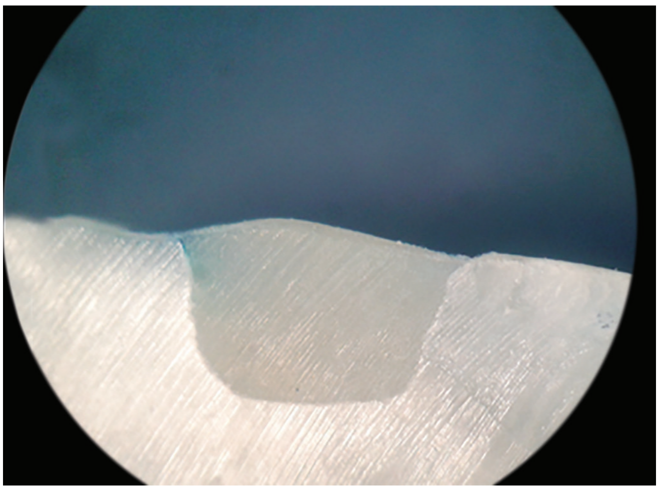

Fig. 3: Image presenting dye penetration up to one-third of occlusal or gingival wall in etch-and-rinse flowable composite (score 1)

DISCUSSION

Restorative dentistry is at the pinnacle of evolution and progress. Yet, microleakage is still an undesirable occurrence that appears to be hard to eliminate. Microleakage has been studied and reviewed to a great extent in the dental literature. Different results are expected with the varying composition of materials and the methodologies followed. Various techniques are available to assess and evaluate microleakage. Dye penetration, electrochemical method, bacterial leakage, fluid filtration, radioisotope labeling, and scanning electron microscopy are the commonly used modalities.[1-19] Among the various methods, dye penetration has been used widely to assess microleakage because of its sensitivity, ease of use, and convenience.

Dentin-bonding technology has evolved drastically from what was introduced by Buonocore in the early 1950s. Bonding systems have been through a complete transformation from the total etch bonding agents to self-etching primers. The advent of self-etching primer adhesives has simplified the resin bonding. The very conventional application of etchant followed by rinsing has been eliminated. Bonding can be done under relatively dry conditions, avoiding wet bonding variables. These self-etching primer adhesives can be used to etch both ground enamel and dentin simultaneously.

Dyad Flow, a self-adhering composite resin, combines all-in-one bonding system and a flowable composite, eliminating the need for a separate adhesive application. The bonding mechanism relies on the adhesive monomer glycerol phosphate dimethacrylate (GPDM). Theoretically, the phosphate group present in GPDM is responsible for the acid-etching property of the resin. The dimethacrylate functional groups are involved in cross-linking reactions with other methacrylate monomers thus, providing mechanical strength to the adhesive material [Kerr Technical Bulletin]. Based on the pH declared by the manufacturer (1.9), Dyad Flow can be expected to interact with dental substrate similarly to a mild self-etch adhesive. Owing to the novelty of this new self-adhering flowable composite material, it seemed interesting to investigate further its sealability.

This study intended to assess the sealing ability of self-adhesive flowable composite compared with a conventional total etch-based flowable composite resin. A simple, less technique sensitive, and less expensive dye penetration method followed by stereomicroscopic evaluation was undertaken. It was observed that self-adhesive flowable composite presented better sealability as it showed no microleakage around the restorations when compared with total etch system.

Hygroscopic expansion and relatively low polymerization shrinkage might be advocated as possible reasons for such satisfactory performance. Concerning the hygroscopic expansion, it is now understood that acidic resins absorb more water than neutral resins.[6,7] Several factors have been reported that affect the amount of water sorption by resins. Among them, the chemical nature of matrix monomers and matrix/filler content has gained considerable interest.[8] It has been observed that in adhesive monomers with polymerizable and functional groups linked by spacer groups, the molecular design influences the hygroscopic expansion of the resulting polymer.[4]

A hygroscopic expansion higher than that of urethane dimethacrylate (UDMA)-based polymers has recently been reported for Dyad Flow and related to the hydrophilic acid phosphate group and the spacer group in the adhesive monomer GPDM.[9] It can be assumed that by compensating the polymerization shrinkage, hygroscopic expansion of Dyad Flow might have resulted in the better sealability in the present study. The satisfactory sealing performance of Dyad Flow can also be accounted for the uniqueness of the dynamics in its adhesion/polymerization process.

During the conventional resin-based restorative procedures, the adhesive solution and the composite resin restorative material are sequentially used. Here, the curing of the restorative material occurs after bonding is accomplished. Polymerization stress of the composite resin may act as a competitor of the bond just established by the adhesive with the tooth.[9-11] In the case of Dyad Flow, which is devoid of additional adhesive, bonding and polymerization process of the resin occur simultaneously. As the viscoelastic flow can occur simultaneously with the bonding process, it can be assumed that the competition between bonding and curing stress is reduced, thereby favoring a better marginal adaptation of the material.

CONCLUSION

Within the limitations of the study setup, Dyad Flow used as class V cavity restorative material, provided satisfactory sealing ability. The outcome of microleakage study suggests that adequate marginal seal can be achieved in the clinical setting, but clinical acceptability of Dyad Flow has to be verified with a larger sample size and/or in-vivo studies.

REFERENCES

1. Vaidyanathan TK, Vaidyanathan J. Recent advances in the theory and mechanism of adhesive resin bonding to dentin: a critical review. J Biomed Mater Res B Appl Biomater 2009 Feb;88(2):558-578.
2. De Munck J, Van Landuyt K, Peumans M, Poitevin A, Lambrechts P, Braem M, Van Meerbeek B. A critical review of the durability of adhesion to tooth tissue: methods and results. J Dent Res 2005 Feb;84(2):118-132.
3. Finger WJ, Shao B, Hoffmann M, Kanehira M, Endo T, Komatsu M. Does application of phase-separated self-etching adhesives affect the bond strength? J Adhes Dent 2007 Apr;9(2):169-173.
4. Moszner N, Salz U, Zimmermann J. Chemical aspects of self-etching enamel-dentin adhesives: a systematic review. Dent Mater 2005 Oct;21(10):895-910.
5. Vichi A, Margvelashvili M, Goracci C, Papacchini F, Ferrari M. Bonding and sealing ability of a new self-adhering flowable composite resin in class I restorations. Clin Oral In¬vest 2013 Jul;17(6):1497-1506.
6. Naga AA, Yousef M, Ramadan R, Fayez Bahgat S, Alshawwa L. Does the use of a novel self-adhesive flowable composite reduce nanoleakage? Clin Cosmet Investig Dent 2015 Mar;7:55-64.
7. Erickson RL. Surface interactions of dentin adhesive materials. Oper Dent 1992;Suppl 5:81-94.
8. Hirasawa T, Hirano S, Hirabayashi S, Harashima I, Aizawa M. Initial dimensional change of composites in dry and wet conditions. J Dent Res 1983 Jan;62(1):28-31.
9. Hosaka K, Nakajima M, Takahashi M, Itoh S, Ikeda M, Tagami J, Pashley DH. Relationship between mechanical properties of one-step self-etch adhesives and water sorption. Dent Mater 2010 Apr;26(4):360-367.
10. Ferracane JL. Hygroscopic and hydrolytic effects in dental polymer networks. Dent Mater 2006 Mar;22(3):211-222.
11. Parolia A, Adhauliya N, de Moraes Porto IC, Mala K. . A comparative evaluation of microleakage around class V cavities restored with different tooth colored restorative materials. Oral Health Dent Manag 2014 Mar;13(1):120-126.
12. Versluis A, Tantbirojn D, Lee MS, Tu LS, Delong R. Can hygroscopic expansion compensate polymerization shrinkage? Part I. Deformation of restored teeth. Dent Mater 2011 Feb;27(2):126-133.
13. Swift EJ Jr, Hansen SE. Effect of new bonding systems on microleakage. Am J Dent 1989 Jun;2(3):77-80..
14. Swift EJ Jr. Microleakage of dentin adhesive systems. J Esthet Dent 1991 May-Jun;3(3):91-94.
15. Hansen EK. Three-year study of cervical erosions restored with resin and dentin-bonding agent. Acta Odontol Scand 1989 Oct;47(5):301-306..
16. Duke ES, Robbins JW, Snyder DS. Clinical evaluation of a dentinal adhesive system: three-year results. Quintessence Int 1991 Nov;22(11):889-895.
17. Fusayama T, Nakamura M, Kurosaki N, Iwaku M. Non-pressure adhesion of a new adhesive restorative resin. J Dent Res 1979 Apr;58(4):1364-1370.
18. Kanca J 3rd. Bonding to tooth structure: a rational rationale for a clinical protocol. J Esthet Dent 1989 Jul-Aug;1(4):135-138.
19. Garcia RM, Morelli AE, da Silva BS, Giongo BM, Pollheim CP, Largura GS, Mensch LF, Costa MF, Candiotto NR, Gomes ACR. Bonding performance of a self-adhering flowable composite to substrates used in direct technique. RSBO 2013 Oct-Dec;10(4):343-349.