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COMPARATIVE EVALUATION OF GINGIVAL MICROLEAKAGE BETWEEN 7TH AND 8TH GENERATION BONDING AGENTS IN CLASS II COMPOSITE RESTORATION: AN IN- VITRO STUDY

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ABSTRACT

Aim: To compare gingival microleakage in deep class II cavity with or without using flowable composite and two generations of self-etch dentin bonding agents. Settings and Design: Study was carried out in Sharad Pawar Dental College and Hospital. **Methods and Material**: 60 freshly extracted premolars were taken. Class II box type cavity was prepared on each tooth. All samples were randomly divided into four groups (n=15). Group I (Single Bond Universal, 3M ESPE+ 3M ESPE Filtek Z250), Group II (Single Bond Universal, 3M ESPE+3M ESPE Filtek Z350+3M ESPE Filtek Z250), Group III (FuturaBond DC, Voco America+3M ESPE Filtek Z250), Group IV (FuturaBond DC, Voco America+3M ESPE Filtek Z350+3M ESPE Filtek Z250) were restored respectively. The samples were immersed in Silver nitrate solution and microleakage scores were recorded with Stereomicroscope (32X). **Statistical analysis:** Mean value of microleakage was calculated using Chi Square test. **Results:** Group I when compared with group II, 11 samples with flowable liner and 4 samples of without liner had no microleakage. Group III when compared with group IV, 13 samples with flowable liner and 9 samples of without flowable liner had no microleakage. Group I when compared with group III, 9 samples of 8th generation and 5 samples of 7th generation had no microleakage. Group II when compared with Group IV, 13 samples of 8th generation and 8 samples of 7th generation had no microleakage. **Conclusion:** 8th generation bonding agent showed least microleakage. Also, flowable liner has positive influence in reduction of gingival microleakage in both generations.

KEYWORDS: Deep class II cavity, Microleakage, Self-etch bonding agents.

KeyMessages: In deep class II cavity, the use of flowable liner seems to create positive influence by reducing microleakage at the gingival area. Also, both generations are quite effective in sealing the tooth restoration interface. Hence use of self-etch resins should be encouraged in deep class II cavities.

INTRODUCTION

The practice of adhesive dentistry has changed and uplifted the face of dentistry. This change embraces the concept of Minimal Invasive Dentistry rather than extension of cavity for prevention as conceptualized by Dr.G.V. Black.[1] Contemporary dentistry is more about aesthetics. As the demand for aesthetic tooth-coloured restoration has increased, resin composite restorations are used in more clinical situations. Therefore, it becomes important to assess the longevity and reliability of the resin composites.[2]

Microleakage at the resin-tooth interface is one of major drawbacks and is still considered as an important factor in failure of restorations. The various factors that contribute to the microleakage are polymerization shrinkage, coefficient of thermal expansion, modulus of elasticity, oral environment such as temperature changes and occlusal forces.[11]

Previously microleakage studies have proved that a resin adhesive bond to enamel margins show less microleakage than those in non-enamel margins. There is proof that the absence of enamel tooth structure on the cavity margins located below the CEJ make them more vulnerable to microleakage. There are many cases frequently encountered for class II cavities that are present below the CEJ. As dentin has a very dynamic nature, it becomes difficult to bond resins to the dentin.[11,12] To enhance adhesion, various improvements have been done to create a strong bond between the dentin and the resin.[15]

Gingival microleakage is one of the major problems present with deep class II cavities. This is due to the 2 main reasons polymerization shrinkage of composite and poor bonding of composite to dentin.[20]

Researchers have suggested various methods to combat the phenomena of polymerization shrinkage. Use of incremental layering techniques will reduce the bonded/unbonded ratio which will consequently reduce the stress level within the cavity. Placement of composite restorations in an oblique fashion and also in at least three increments helps to reduce the polymerization shrinkage. Various other techniques of layering include the horizontal occlusogingival layering, the wedge-shaped oblique layering technique, split technique. By improving the bond strength of the various bonding agents, can help to overcome the problem of polymerization shrinkage.[21]

The 7th generation dentin bonding system is a self‑etch system that combines an etchant, primer, and adhesive in one container compared to total‑etch or etch and rinse systems in which separate etchant, primer, and adhesive monomers are utilized. These systems are called as self‑etch adhesives or all in one adhesive which requires no mixing.[19]

Recently 8th generation bonding agents have been introduced. It has the advantage of being a dual cure type of bonding agent, self-cure as well as light cure. It is a single dose delivery system which prevents solvent evaporation. Also, it has an immediate stick effect that guarantees that the bond is not blown away from the cavity while air drying. This may provide superior marginal integrity and protection against dentinal sensitivities.[22]

The present study is carried out to compare the microleakage at gingival margin between two new generation bonding agents in class II cavities. The aim of the study is "to compare gingival microleakage in deep class II cavity with or without using flowable composite and two generations of self-etch dentin bonding agents using 50% silver nitrate solution under Stereomicroscope."

SUBJECTS AND METHODS

Inclusion criteria

The samples selected for the study were

1. Maxillary premolars
2. Caries free and were
3. Extracted for orthodontic purpose.

Exclusion criteria

1. Grossly carious tooth and
2. Teeth other than premolars were excluded from the study.
3. Fractured teeth

The extracted teeth were stored in 0.9% Normal saline solution and cleaned ultrasonically to remove the debris. 60 freshly extracted human premolars for orthodontic purposes were selected for the study. Deep class II box preparation (with height of the cavity- gingival floor at 1mm below CEJ, depth 2mm and width 4 mm) were prepared on all the teeth using high speed hand-piece with continuous water cooling. The prepared samples were divided into 4 equal groups (n=15) according to the generation of bonding agents and with or without using flowable composite.

Table 1: - Distribution of samples and materials.

GROUPS	Type of Bonding Agent	Use of flowable composite	Final resin restoration
Group I	7th generation (Single Bond Universal, 3M ESPE)	-	3M ESPE Filtek Z250
Group II	7th generation (Single Bond Universal, 3M ESPE)	3M ESPE Filtek Z350	3M ESPE Filtek Z250
Group III	8th generation (FuturaBond DC, Voco America)	-	3M ESPE Filtek Z250
Group IV	8th generation (FuturaBond DC, Voco America)	3M ESPE Filtek Z350	3M ESPE Filtek Z250

General Procedure

Box shaped class II cavity was prepared using burs (MANI DIA SF 41, TF -20, and EX-24). Application of bonding agent (according to the manufacturer's instructions) was done for all groups.

For the groups I and II, application of 7th generation bonding agent (3M ESPE, Single Bond Universal) was applied according to the manufacturer's instructions while for the groups III and IV, application of 8th generation bonding agent (FuturaBond DC, Voco America) was done. A thin layer of flowable resin (3M ESPE Filtek Z350) 0.5-1 mm was applied to the samples of group II and 1V.

All the groups were restored with packable resin (3M ESPE Filtek Z250) in approximately 3-4 increments, depending on the depth of the gingival wall. Each increment was light cured for 20 seconds with LED curing light (LED.D, Woodpecker) with a power input of AC100V-240V and a light output of 850mW/cm² - 1000mW/cm².

After the clear matrix was removed, the restorations were cured from the facial and lingual portion of the tooth to assure adequate curing relating with clinical protocol. The restorations were finished with high speed finishing burs and Shofu finishing kit discs. The restored samples

were stored in normal saline until thermocycling, to simulate with the normal oral temperature at 6℃, 37℃ and 54℃.

Application of nail varnish was done over the thermocycled tooth specimens except 1mm around the gingival margin. The apex of all the teeth were sealed with green stick compound.

Specimen staining

Areas of microleakage were identified using a 50% aqueous solution of AgNO3 as described by **Vinay and Shivanna in 2010.**[23] The scoring criteria used is:

Table 2: Scoring criteria for Microleakage.

Score 0	**No Microleakage**
Score 1-	Microleakage at ½ of the gingival floor
Score 2-	Microleakage seen at full length of gingival floor
Score 3-	Microleakage seen at apical 3rd of the axial wall of the cavity
Score 4-	Microleakage at 2/3 of the axial wall of the cavity
Score 5-	Microleakage at full length of the axial wall of the cavity.

Each group of sample was placed in 10 ml of freshly prepared 50% silver nitrate solution for 2 hrs in darkness. The specimens were washed thoroughly in distilled water and stored in developing solution and then exposed to sunlight for 24 hours.

The teeth were sectioned with the help of diamond disk and were evaluated for microleakage by the extent of the penetration of silver nitrate which appeared black areas between the restoration and tooth interface under a stereomicroscope (32X) at various levels.

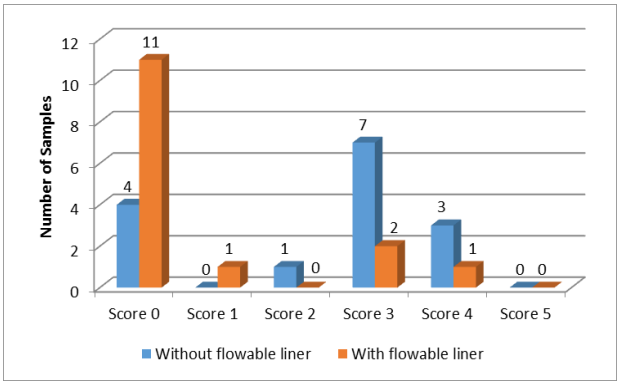
RESULTS

The evaluated specimens for microleakage were scored under a scoring criterion and the mean value of microleakage was done by using Chi Square test. The level of significance will be set at P=0.05.

Table 3: 7th generation without and with flowable liner.

	Without flowable liner	With flowable liner	Total	Chi-square value	p-value
Score 0	4	11	15	9.044	0.060
Score 1	0	1	1		
Score 2	1	0	1		
Score 3	7	2	9		
Score 4	3	1	4		
Score 5	0	0	0		

Table 1 shows that out of 15 samples, maximum samples (n=11) with flowable liner were having no microleakage (score 0) and only 4 samples of without liner had no micro-leakage. A total of 7 samples showed micro-leakage at apical 3rd of the tooth, which was scored 3 whereas with liner only 2 samples were of this category. Micro-leakage at 2/3 of the tooth level (score 4) was seen in 3 samples of without liner and 1 sample of with liner. And these differences were not significant (p>0.05)



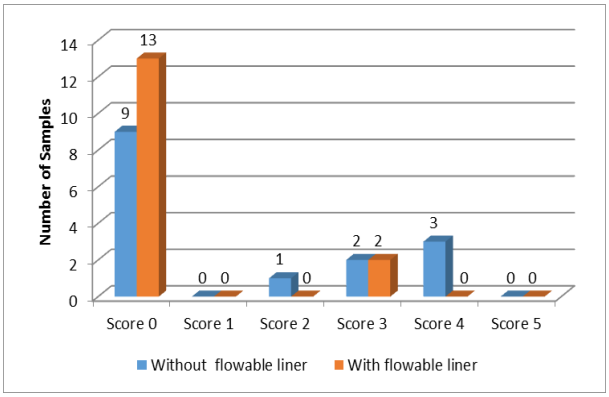
Graph 1: Comparison of Microleakage of Group I and Group II.

Graph 1. The graph depicts that out of 15 samples, samples with flowable liner showed less microleakage (11 samples). A total of 7 samples showed microleakage in group I.

Table 4: 8th generation without or with flowable liner.

	Without flowable liner	With flowable liner	Total	Chi-square value	p-value
Score 0	9	13	22	4.727[a]	0.193
Score 1	0	0	0		
Score 2	1	0	1		
Score 3	2	2	4		
Score 4	3	0	3		
Score 5	0	0	0		

Table 2 shows that out of 22 samples of 8th generation, maximum samples (n=13) with flowable liner were having no micro-leakage (score 0) and only 9 samples of without flowable liner had no micro-leakage. A total of 3 samples which was without liner showed micro-leakage at apical 2/3rd of the tooth (scored 4) and with liner no samples were of this category. Micro-leakage at 1/3rd of the tooth level (score 3) was seen in 2 samples of without liner and 2 samples of with liner. And these differences were not significant (p>0.05)



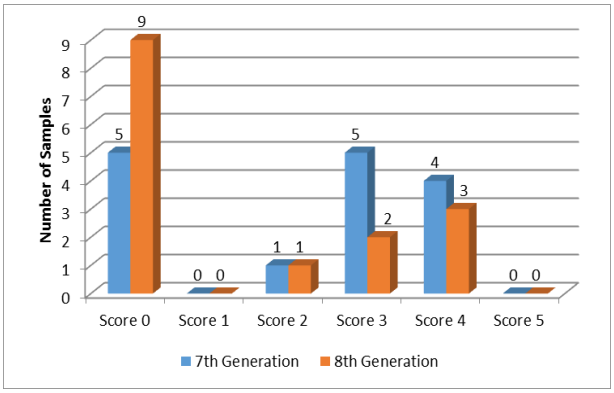
Graph 2: Comparison of Microleakage of Group II and Group IV.

Graph 2: Graph compares samples of 8th generation bonding agent with or without using flowable liner. Out of 15 samples in group III, only 9 samples showed microleakage whereas in group IV, only 13 samples showed microleakage.

Table 5: 7th and 8th generation without flowable liner.

	7th Generation	8th Generation	Total	Chi-square value	p-value
Score 0	5	9	14	2.571[a]	.463
Score 1	0	0	0		
Score 2	1	1	2		
Score 3	5	2	7		
Score 4	4	3	7		
Score 5	0	0	0		

Table 3 shows that out of 14 samples without flowable liner, 9 samples of 8th generation were having no micro-leakage (score 0) and only 5 samples of 7th generation had no micro-leakage. A total of 5 samples showed micro-leakage at 1/3rd of the tooth, which was scored 3 whereas of 8th generation only 2 samples shows the same result. 4 samples of 7th generation and 3 sample of 8th generation shows micro-leakage at 2/3rd of the tooth level (score 4). And these differences were not significant (p>0.05)



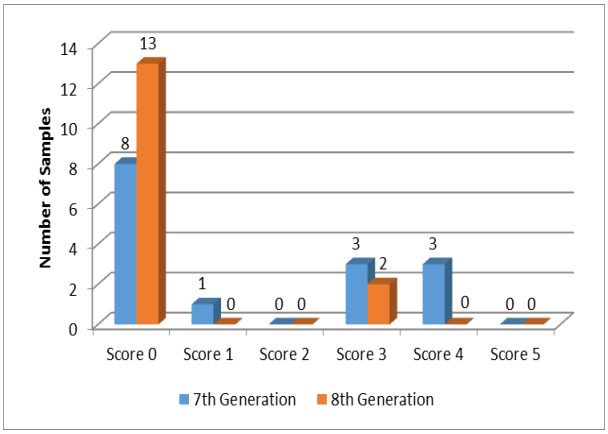
Graph 3: Comparison of Microleakage of samples of Group I with Group III.

Graph 3: This graph compares 7th and 8th generation bonding agents without using flowable liner. Out of 15 samples, 5 samples showed no microleakage in group I whereas 9 samples of group III showed no microleakage.

Table 6: 7th and 8th generation with flowable liner.

	7th Generation	8th Generation	Total	Chi-square value	p-value
Score 0	8	13	21	5.390[a]	0.145
Score 1	1	0	1		
Score 2	0	0	0		
Score 3	3	2	5		
Score 4	3	0	3		
Score 5	0	0	0		

Table 4 shows that out of 21 samples with flowable liner, 13 samples of 8th generation were having no micro-leakage (score 0) and only 8 samples of 7th generation had no micro-leakage. A total of 3 samples showed micro-leakage at 1/3rd of the tooth, which was scored 3 whereas of 8th generation 2 samples shows same result. 3 samples of 7th generation and no sample of 8th generation shows micro-leakage at 2/3rd of the tooth level (Score 4). And these differences were not significant (p>0.05)



Graph 4: Comparison of Microleakage of samples of group II with group IV.

Graph 4: This graph compares samples of group II with group IV. Out of 15 samples of group III, 8 samples showed no microleakage whereas out of 15 samples of group IV, 13 samples showed no microleakage.

DISCUSSION

Modern era is all about aesthetic dentistry and much of credit goes to the development of adhesives. Microleakage is one of the major drawbacks of an adhesive restoration.

Recently, 7th and 8th generation bonding agents have been introduced with the advantage that they have, acid, primer and adhesive in a single bottle. The 8th generation bonding agent has nanofiller particles and also it is dual cure in nature. Therefore, in this study, the microleakage of both the dentin adhesives were evaluated and compared in deep class II cavities.[22, 24]

Most of the microleakage occurs due to polymerization shrinkage. This shrinkage can be compensated by curing the composites in 2mm increments[25] and using different curing modes such as soft, ramp or pulse delay.[26] Another technique is the use of class II open sandwich method by using glass ionomer cement or Resin Modified glass ionomer cement between the cervical margins of dentin and occlusal restoration. But due to the dissolubility of GIC and RMGIC, they have been reported to show less sealing ability as they can dissolve in oral environment with time.[27, 28]

New formulations of flowable resins have introduced, with lower filler content and less viscosity and are recommended to be used a liners at CEJ margins of the proximal box of class II restorations; supposedly, to increase the marginal integrity and to reduce the post-operative sensitivity. And this has nowadays gained popularity and has become the ideal choice in the open sandwich cases of class II cavity. Hence, in this study, flowable resins were also used as an intermediate layer in class II cavities, at the gingival floor to determine and evaluate the effect of Flowable composites on the microleakage.[29]

In the present study, silver nitrate solution was freshly prepared and was used as a dye to determine the microleakage as it has a molecular weight of 169.872 g/mol compared to methylene blue dye having molecular weight of 319.85 g/mol. The mean diameter of bacteria usually ranges from 0.3-1.5 microns.[30] Therefore, using methylene blue cannot differentiate between too narrow and very wide gaps to allow the passage of bacteria. Hence, to avoid such error, freshly prepared silver nitrate solution was used to evaluate microleakage. The microleakage score were evaluated by the evaluation of black areas caused by the penetration of silver nitrate solution by stereomicroscope (32X). The scoring criteria used was same as used by **Vinay and Shivanna in 2010.**[31]All the samples in this study were subjected to thermocycling to simulate the conditions of oral environment.[32]

In the present study, when group I was compared with group II, no statistical significant difference was found. Though a positive influence of flowable resin was seen in samples treated with Filtek Z350. This in accordance to the study done by **Gowda et al in 2015**. In their study, microleakage in class II composite restorations without/with RMGIC and flowable composite liner

(Filtek Z350) was evaluated, and they had concluded that there was a statistically significant reduction in gingival microleakage with flowable resin (Filtek Z350) compared with RMGIC and also in comparison to the other groups where liner was not placed.[33]

When group II was compared with group IV, the microleakage was less for samples with flowable resin, though there were no statistically significant results. The 8th generation bonding agent with or without using flowable liner has shown the best results in deep class II cavities. This can be attributed to the fact as stated by **Pashley et al.,** the hydrophilicity of HEMA makes it an excellent adhesion promoting monomer and by enhancing wetting of dentin it significantly improves bond strength, thereby reducing microleakage. HEMA undergoes hygroscopic expansion after polymerization, thereby resulting in stronger bonds to the dentin surface.[34]

Also , when group I was compared with group III, i.e. the microleakage of two different generations namely 7th generation and 8th generation was compared, no statistical significant results were obtained , although, it was found that the 8th generation dentin bonding agent (Futurabond DC) showed the least microleakage when compared to the 7th generation (Adper single bond 3M) dentin bonding agent which is in accordance to the studies done by **Joseph et al**[35] **and Kambale et al**[36] that concluded 8th generation dentin bonding agent showed better bond strength to 6th and 7th generation dentin bonding agents.

This can be attributed to the fact that 8th generation dentin bonding agent (Futurabond DC) contains polyfunctional adhesive monomers (phosphoric acid modified methacrylate esters). These acid esters, when mixed with water, produces a favourable lower pH value of 1.4 as in comparison to unfavourable higher pH value of 1.8 and 2.4 of the 7th and 6th generation dentin bonding agents, respectively. This lower pH helps in complete removal of smear layer and the hydroxyapatite is demineralized, creating a deeper retentive pattern on the tooth surface. Also 8th generation dentin bonding agent (Futurabond DC) is a nanofilled adhesive which forms a thicker adhesive layer and a more flexible interface, which may help to counteract stress resulting from polymerization shrinkage of the resin composite.[22]

Comparison of group II and IV was done to evaluate and compare the influence of a thin layer (1 mm) of flowable composite under the hybrid resin restoration, because several studies have indicated that the flowable resin is able to absorb shrinkage stresses due to the polymerization of the composite placed over it while also reducing microleakage.[37]

The microleakage was more for samples without flowable resin both for 7th and 8th generation. This can be attributed to the fact that the elastic intermediary layer formed by the flowable composite with a lower thickness might be able to absorb the stress that occurs by functional loading or temperature changes.

Payne et al in 1999 compared effectives of marginal seal of flowable resin and glass ionomer cement and found that the minimum microleakage was present with the group wherein flowable resin was used as an intermediary layer.[38]

Leevailoj et al in 2001, evaluated packable composite resin placement with and without flowable composite and found that there was less microleakage in more samples when the use of flowable resin was done as an intermediary layer.[39]

Hence it can be concluded from the study that 8th generation bonding agent has better sealing ability than 7th generation bonding agent. Also, it was concluded that 8th generation bonding agent when used with a flowable liner showed better sealing ability than all the 3 groups.

CONCLUSION

The 8th generation bonding agent shows less gingival microleakage in deep class II cavities when compared with 7th generation bonding agent. The use of flowable liner has a positive influence in the reduction of gingival microleakage both in 7th and 8th generation bonding agent. This study recommends that both the agents are comparable to each other and provide the least microleakage in deep class II cavities. Nevertheless, in a clinical situation, use of flowable liner will be quite useful with the subsequent bonding agent.

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