Influence of age and etching technique on the microleakage in Class-V composite restorations: An in-vitro study

ABSTRACT

Aim: The objective of current research was to evaluate the impact of patient's age on the microleakage in Class-V composite restorations.

Study design: Research article.

Methodology:30 permanent human molars from various age groups (n=10 each) were collected. The teeth were categorized based on age, Group I (less than 30 years), Group II (30-50 years), and Group III (more than 50 years), standardized Class-V tooth preparations were prepared. Subsequently, each group has further two subgroups: selective enamel etching (Sb A) and self-etching (Sb B), using universal adhesive (3M single bond). Following this, restoration of teeth were done using Z350 composite, and microleakage was analysed by dye penetration method via stereomicroscope and corresponding scoring were recorded. Mann- Whitney Test and Kruskal- Wallis Test was done for statistical analysis.

Results: The group III subgroup A and B showed highest microleakage (2.40 and 2.80) followed by group II (1.20 and 1.60) and least in group I (0.40 and 0.80) respectively (P<.005). Therefore, more microleakage was seen with self-etch group as compare to selective etch.

Conclusion: Influence of age of patient had significant impact on Class-V restorations. Also, more microleakage was observed in self-etch group as compared to that of selective etch technique.

*Keywords: [*microleakage, class-V composite restorations, selective-etch, self-etch technique]

1. INTRODUCTION

Composites are highly regarded in restorative dentistry due to their tooth-like appearance and favourable properties, such as aesthetics, adhesion, and the preservation of tooth

structure. They are a popular choice among dentists. Nevertheless, resin composites present several challenges, including sensitivity to technique, polymerization shrinkage, and an increased risk of microleakage and secondary caries [1]. Microleakage is a critical factor determine the durability of restorations. Consequently, contemporary adhesive restorative dentistry strives to enhance the bonding of various restorations by minimizing microleakage. Microleakage at the tooth and restoration interface can compromise longevity of restorations by allowing bacteria, fluids, molecules, or ions to penetrate, leading to secondary decay, sensitivity, and pulpal infections [2].

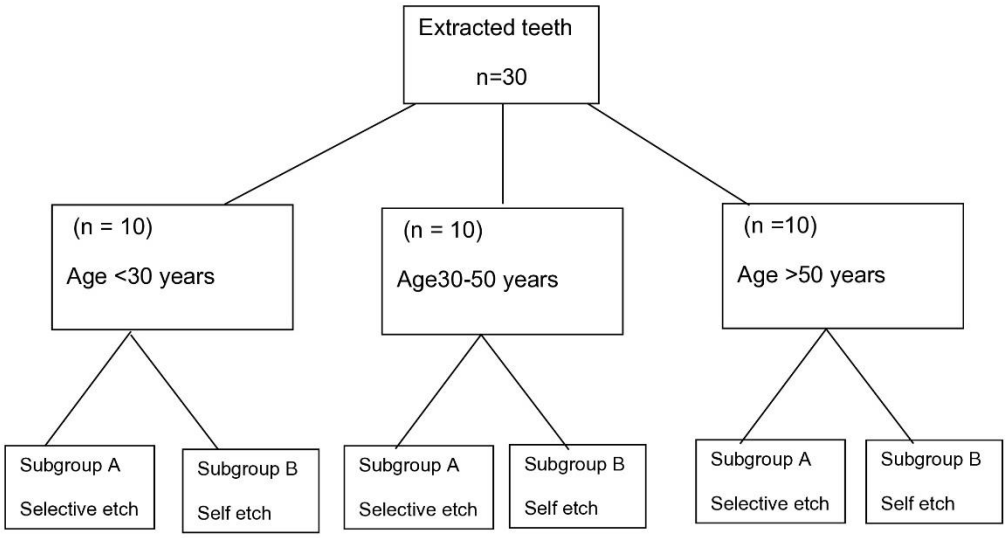
Class-V restorations, a common dental procedure for addressing lesions at the gingival margin and buccal/ lingual surfaces. These lesions may be caused by factors such as abrasion, erosion, or caries. Several factors contribute to the microleakage, including material selection, tooth preparation, bonding of restorations and patient-related factors.[3] Microleakage is a particular concern in Class V tooth preparation because the margins of these restorations are typically situated within the dentin and cementum. Additionally, the cuspal flexure resulting from lateral movements gives rise to compression and tension in the cervical region of the teeth.[4] Furthermore, restorations in cervical areas possess significant challenges due to difficulties in control of moisture, caries access, and their close adaptation to cervical area. Additionally, it has a greater configuration factor (C-factor) due to its design of preparation, making microleakage a particularly critical concern. [5, 21-22]

The chief concern in restoring Class-V tooth preparation is the maintenance of isolation in gingival third region. Also, off-center forces in cervical areas results in significant stress concentrations which create cervical flexural forces.[6],[7] Hence, present study aimed to determine the corelation between microleakage and patient age in Class-V restorations and also to analyse the effect of using selective etch and self-etch technique. The null hypothesis proposed were that the age of patients has no impact on the class-V restorations, and selective etch bonding does not differ from self etch bonding in regard to microleakage on cervical restorations.

2. MATERIAL AND METHODS

In this research, freshly extracted human molar teeth were used. The teeth with incomplete roots, resorption and fractured were discarded. 30 teeth were finally selected for the study as depicted in Figure 1. They were cleaned of attached tissues and stored in normal saline.

Figure 1: Consort Diagram



These were then distributed into three groups (n=10 each) according to age groups as calculated by statistical formula: Input: Tail(s) = Two, Proportion p2 = 0.2, Proportion p1 = 0.8, Output: Critical z = -1.9599640, 10 samples are required for each group in the study. Subsequently, standardized class-V tooth preparations were done, followed by restoration with composite material.

Group I include Age less than 30 years (n=10)
Group II include Age =30-50 years (n=10)
Group III include Age more than 50 years (n=10)
Subgroup A – Selective enamel etch
Subgroup B – Self- etch technique

2.1 Tooth preparation- Standardized class-V tooth preparations were done in all the samples using the following technique: the surface of tooth preparations were situated above the CEJ (1mm), in the enamel. The depth and the mesiodistal distance of the preparations were 1 mm and 4 mm, respectively as presented in figure 2 (a). The tooth preparation depths were confirmed using a periodontal probe. The materials used in this study are described in Table 1.

Table 1: List of materials used in this study are description

Materials	**Description**
Etchant	37% phosphoric acid (Frost, Ethcing gel-blue, Ammdent)
Universal adhesive	(3M ESPE Adper Single Bond Universal Adhesive, Germany)
Z350 composite	Nanocomposite (3M ESPE Filtek Z350 Xt Restorative Syringe)

2.2 Restorative procedure- In this, selective enamel etching was done in subgroup A of all the three groups with etchant 37% phosphoric acid (Frost, Ethcing gel-blue, Ammdent) for 15-20 sec and rinsed, after that universal adhesive (3M ESPE Adper Single Bond Universal

Adhesive, Germany) was applied and cured for 20 sec. whereas in subgroup B, self- etching was done with universal adhesive and cured for 20 sec Figure 2 (b and c). Then, tooth preparations of all the samples were restored with Z350 composite (3M ESPE Filtek Z350 Xt Restorative Syringe) Figure 2 (d).

Following this, the apices of the specimens were closed with sticky wax, and every specimen surfaces, excluding 1 mm of the tooth restoration margins, were covered by two coats of clear nail varnish and left to air dry Figure 2(e). Then specimens were placed at 37°C for 24 hours as immersed in 1% methylene blue dye solution (pH = 7.4). Subsequently, the specimens were sectioned longitudinally in a buccolingual direction using a low-speed diamond blade under constant water lubrication to remove any debris created by the cutting of specimens Figure (2f).

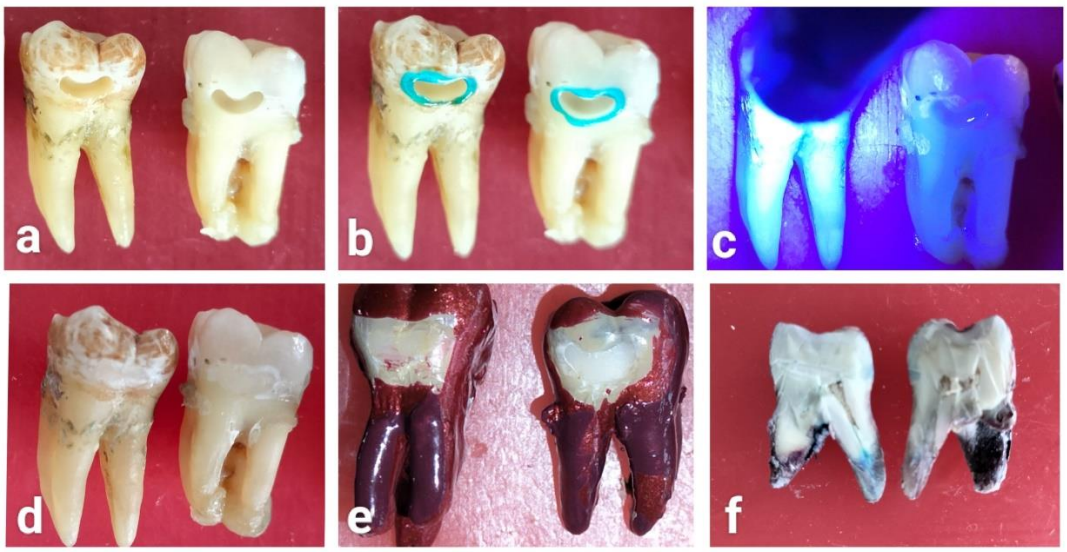


Figure 2: (a) Class-V tooth preparation, (b) selective etching, (c) light curing of bonding agent, (d) composite restoration, (e) nail varnish, (f) sectioning of sample.

The overall microleakage rate using methylene blue as a marker was assessed via the dye penetration method. Each section was then assigned a score based on the extent of marker penetration, using the following scoring system (Table 2).

Table 2: Scoring criteria for estimation of dye penetration

Scores	**Dye penetration**
0	No dye penetration
1	Dye penetration less than 1/3 of the gingival floor
2	Dye penetration beyond 1/3 of the gingival floor, upto the axial wall
3	Dye penetration along the axial wall

Surfaces were dried and viewed under a stereomicroscope (Figure 3) and then Mann-Whitney Test and Kruskal- Wallis Test was used to evaluate the obtained data statistically.

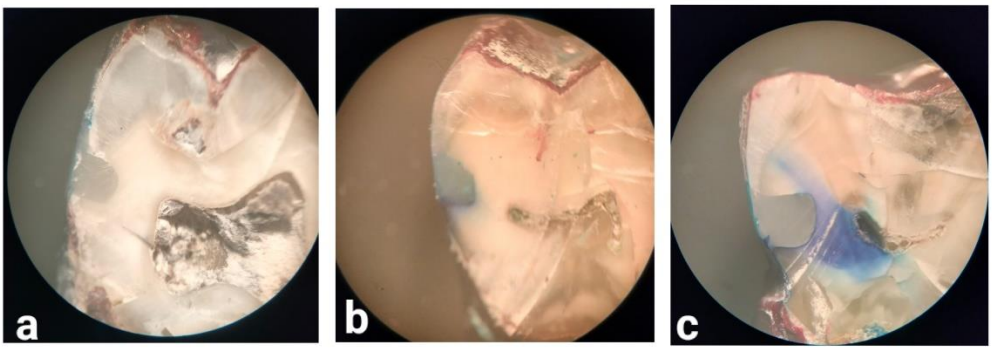


Figure 3:Surfaces were viewed under a stereomicroscope, (a)score 1, (b)score 2, (c)score 3.

3. RESULTS AND DISCUSSION

In case of subgroup-A, lowest mean microleakage (in mm) had been observed in Group I (0.40), followed by Group II (1.20) and highest microleakage observed in Group III (2.40). Also, in subgroup-B lowest mean microleakage (in mm) had been observed in Group I (0.80), than Group II (1.60), and finally highest microleakage observed in Group III (2.80) as described in Table 3.

Table 3: Mean of microleakage (in mm) among different age groups and bonding technique

Groups	**Subgroup A**	**Subgroup B**
	Mean (in mm)	Mean (in mm)
Group 1	0.40	0.80
Group 2	1.20	1.60
Group 3	2.40	2.80

No differences of microleakage were seen between subgroup A and B statistically as presented in Table 4.

Table 4: Statistical analysis of microleakage between subgroup A and B

	Subgroup A vs B
Group 1	P= 0.419; NS
Group 2	P= 0.663; NS
Group 3	P= 1.000; NS

Also, the statistical analysis of microleakage among various groups was depicted in Table 5. In subgroup-A, while comparing group I vs group II no statistical significant differences (P=.118) were observed, however when comparing group I vs group III, also, group II vs group III in subgroup A, statistical significant differences (P= .006 & .012 respectively) were observed. Moreover, in case of subgroup-B, while comparing group I vs II, also group II vs

III, no statistical significant (NS) differences (P= .324 & .125 respectively) were observed, on the other hand, correlation between group 1 vs 3 was statistically significant (P= .009). These results indicated that selective etching that is subgroup-A, exhibited lower levels of microleakage compared to that of self-etching subgroup-B. The analysis also revealed that participants aged under 30 years exhibited lower levels of microleakage compared to that of over 50 years.

Table 5: Statistical analysis of microleakage among various groups

	Subgroup A	Subgroup B
Group 1vs 2	0.118; NS	0.324; NS
Group 1 vs 3	0.006*	0.009*
Group 2 vs 3	0.012*	0.125; NS

4. DISCUSSION

The intricate nature of Class V cavities, characterized by borders extending into both enamel and dentin/cementum, poses a bonding challenge for restorative materials. The primary concern when restoring Class V tooth preparations is the potential for leakage placed within the dentin, at the gingival margin.[7] The effectiveness of recent bonding systems is frequently assessed according to their capability by bonding to healthy dentin. Nevertheless, clinical training often involves encountering various pathological dentin substrates, including carious and sclerotic dentin. Thus, addressing these diverse substrates poses additional challenges in achieving successful restorations.[8],[9]

In this research, significant differences were noticed inrelation to both age of individuals and bonding techniques; hence, the null hypothesis was rejected.

The mean microleakage values showed increasing trend with age of patients, with the highest values observed in group 3 (elderly study population) while the least value was recorded in group 1(younger study population), irrespective of bonding techniques and these findings were in accordance with that of various studies [10],[11],[12]. This might be attributed to the closure of tubules due to mineral salts accumulation with aging, resulting in inadequate formation of resin tags that results in improper bonding and increased microleakage.

On the contrary, it was suggested by Kusunoki et al, that sclerotic dentine revealed good marginal adaptation of composites as compare to normal dentin which was similarly primed. This might be because the sclerotic dentine structure was observed to be advantageous because it is suitable for bonding and instant bond strength in the sclerotic cervical lesion was came out to be better.[13]

Furthermore, bacteria and mineral crystals within the sclerotic dentin in older individuals might serve as effective barriers to the diffusion of primer and resin infiltration which affects bonding and thus results in the increased microleakage.[14]

Moreover, greater levels of microleakage were noted in all the experimental group treated with self etch technique (subgroup B) as compared to selective etch technique (subgroup A)

irrespective of age factor. A similar study conducted by Yollar et al, [12],[15],[16] showed analogous findings and noticed that the amount of microleakage was reduced when phosphoric acid was used for etching of enamel and/or dentin.

This may be because etchant used in the selective etch technique enhance the adhesive resin monomers infiltration into the enamel, which facilitates strong adhesion between the tooth and composite resin. [17],[18] Furthermore, selective etch bonding allows a more precise and controlled placement of the bonding agent along the enamel margins that result in better marginal adaptation which reduces the risk of marginal leakage and recurrent decay over time.[18]

On the contrary, a study by Yalniz et al,[19],[20] indicated that no statistical significant differences had been seen between the bonding techniques (selective etch and self-etch) because in self-etch adhesives, dissolution of smear layer by the acidic quality of the reactive monomers are important for demineralizing the underlying dentin similar to selective etch adhesives. [19]

Besides, greater microleakage was observed with the self-etch technique. Because the superficial layers of sound or sclerotic dentine may not etch through the self-etching primer.[13] Moreover, sclerotic dentin demonstrates resistance to both self-etching primers and phosphoric acid. Thus, impedes the hybridized process of the basal dentin, further complicating the restoration procedure.[15],[16]

Therefore, the finding of the present research suggested a significant relation between patient age and the occurrence of microleakage in class-V restorations.[10] Therefore, the observed age related differences in microleakage highlighted the complex interplay between tooth structure.

Overall, selective etch bonding performed superiorly than self-etch bonding in Class V restorations displaying improved adhesion, reduced post-operative sensitivity, enhanced marginal integrity, and minimized microleakage.[15],[16] These factors provide the continued success and longevity of the restoration, making selective etch bonding the preferred choice for many dental practitioners in such cases.[17]

Considering the constraints of the study, it was observed that the volunteers who participated were predominantly from a specific geographical area. It is imperative to conduct additional research to substantiate and validate the proposed hypotheses, thereby enhancing comprehension of the evaluated products. This entails designing and executing further studies that encompass a more diverse demographic to ensure broader applicability and reliability of the findings.

5. CONCLUSION

As per the outcomes of this research, the effect of aging significantly affects microleakage in Class-V restorations.

Moreover, there was a greater incidence of microleakage observed in self-etch group than selective etch group, particularly when age was taken into account.

Therefore, the recommendation is to prioritize the use of the selective etch technique over self-etch when undertaking Class-V tooth restorations, particularly in old citizens.

ETHICAL APPROVAL

Approved By Local Ethical Committee

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Option 1:

Author(s) hereby declare that no generative ai technologies such as large language models (chatgpt, copilot, etc) and text-to-image generators have been used during writing or editing of manuscripts.

Option 2:

Author(s) hereby declare that generative ai technologies such as large language models, etc have been used during writing or editing of manuscripts. This explanation will include list the name, version, model, and source of the generative ai technology and as well as the all input prompts provided to a generative ai technology

Details of the ai usage are given below:

1.

2.

3.

REFERENCES

1. Ranjitha GR, Vikram R, Meena N, Vijayalakshmi L, Murthy CS. Clinical efficacy of universal adhesives for the restoration of noncarious cervical lesions: A randomized clinical trial. *Journal of Conservative Dentistry* 2020;23:227-32.
2. Swapna MU, Koshy S, Kumar A, Nanjappa N, Benjamin S, Nainan MT. Comparing marginal microleakage of three Bulk Fill composites in Class II cavities using confocal microscope: An: in vitro: study. *Journal of Conservative Dentistry and Endodontics* 2015;*18*:409-13.
3. Rengo C, Goracci, C, Ametrano G, Chieffi N, Spagnuolo G, Rengo S, Ferrari M. Marginal leakage of class V composite restorations assessed using microcomputed tomography and scanning electron microscope. *Operative dentistry* 2015;*40*:440-48.

4. Arisu HD, Üçtasli MB, Eligüzeloglu E, Özcan S, Ömürlü H. The effect of occlusal loading on the microleakage of class V restorations. *Operative dentistry* 2008;33: 135-41.
5. Gupta A, Tavane P, Gupta P, Tejolatha B, Lakhani AA, Tiwari R, Kashyap S, Garg G. Evaluation of microleakage with total etch, self-etch and universal adhesive systems in class V restorations: an in vitro study. *Journal of clinical and diagnostic research JCDR* 2017;11:ZC53.
6. Valizadeh S, Hashemi SF, Hashemikamangar S, Kharazifard M. Microleakage of a self-adhesive composite of class V cavities: effect of surface treatment and thermocycling. *J Cont Dent Pract* 2020;**21**:781–6.
7. Van Meerbeek B, Braem M, Lambrechts P, Vanherle G. Morphological characterization of the interface between resin and sclerotic dentine. *Journal of Dentistry* 1994;22:141—6.
8. Tay FR, Pashley DH. Resin bonding to cervical sclerotic dentin: a review. *Journal of Dentistry* 2004;*32*:173-96.
9. Kwong SM, Tay FR, Yip HK, Kei LH, Pashley DH. An ultrastructural study of the application of dentine adhesives to acid-conditioned sclerotic dentine. *Journal of Dentistry* 2000;7:515—28.
10. Tao L, Pashley DH, Boyd L. The effect of different types of smear layers on dentin and enamel bond strengths. *Dental Materials*. 1988;4:208-16.
11. Ogata M, Harada N, Yamaguchi S, Nakajima M, Tagami J. Effect of self-etching primer vs phosphoric acid etchant on bonding to bur-prepared dentin. *Operational Dentistry* 2002;27:447-54.
12. Yollar M, Karaoglanoglu S, Altiparmak ET, Oktay EA, Aydin N, Ersoz B. The effects of dental adhesives total etch; self-etch and selective etch application procedures on microleakage in class II composite restorations. *European oral research* 2023; 57:151-8.
13. Kusunoki M, Itoh K, Hisamitsu H, Wakumoto S. The efficacy of dentine adhesive to sclerotic dentine. *Journal of Dentistry* 2002;30:91-7.
14. Vasiliadis L, Darling AI, Levers BG. The histology of sclerotic human root dentine. *Archives of Oral Biology* 1983;28:693-700.
15. Kumar AA, Ataide I de N de, Fernandes M. Comparative evaluation of sealing ability of two self-adhesive flowable composites following various restorative techniques in Class V lesions: An in vitro study. *Journal of Conservative Dentistry* 2021;24:508-13.

16. Hegde MN, Hegde P, Chandra CR. Morphological evaluation of new total etching and self etching adhesive system interfaces with dentin. *Journal of Conservative Dentistry* 2012;*15*:151-5.
17. Hegde N, Attavar S, Hegde MN, Hegde ND. Comparative analysis of bond strength and microleakage of newer generation bonding agents to enamel and dentin: An in vitro study. *Journal of Conservative Dentistry* 2020;23:593-7.
18. Karnady JA, Prahasti AE. Comparison of Microleakage on Class V Composite Restoration: Study on Total Etch, Self Etch and Selective Etch Technique. *Scientific Dental Journal 2019;*3:p 47-9.
19. Yalniz AM, Karacan AO, Cakar C, Bagis YH. Comparison of microleakage of Class V restoration with self-etch and selective-etch adhesive systems: an in vitro study. *Int J Prosthodont Restor Dent*. 2019;*9*:51-5.
20. Digole VR, Warhadpande MM, Dua P, Dakshindas D. Comparative evaluation of clinical performance of two self-etch adhesive systems with total-etch adhesive system in noncarious cervical lesions: An: in vivo: study. *Journal of Conservative Dentistry* 2020;*23*:190-5..
21. Bajabaa S, Balbaid S, Taleb M, Islam L, Elharazeen S, Alagha E. Microleakage evaluation in class V cavities restored with five different resin composites: in vitro dye leakage study. Clinical, Cosmetic and Investigational Dentistry. 2021 Sep 27:405-11.
22. Gönülol N, Ertaş E, Yılmaz A, Çankaya S. Effect of thermal aging on microleakage of current flowable composite resins. Journal of Dental Sciences. 2015 Dec 1;10(4):376-82.