Dental Research Journal

Original Article

Microbrush bristle remnants on the bonding surface using different adhesive systems by scanning electron microscope: An *in vitro* study

Shraddha Padwal, Pradeep Shetty, Divya Dudulwar, Kiran Keswani, Vishwajit Lokhande, Manjiri Raje

Department of Conservative Dentistry and Endodontics, D. Y. Patil Dental School, Pune, Maharashtra, India

ABSTRACT

Background: The shelf life of dental restorations relies primarily on the adhesion between tooth and restorative material. Numerous dental adhesive systems have been developed to play a crucial role in enhancing this adhesion. However, the presence of any residues while applying adhesive systems may compromise the adhesive seal, affecting the properties of dental restorations. Thus, this paper aims to assess the presence of microbrush bristle remnants on bonding surfaces using total-etch and self-etch adhesive systems.

Materials and Methods: In the present experimental *in vitro* study, 12 extracted permanent maxillary premolar teeth were decoronated and divided into two groups (n = 6). Application of self-etch adhesive system (Seventh generation) was made on the prepared specimens with the help of microbrush (Cotisen) for group I, and total-etch adhesive system (Fifth generation) was applied on the prepared specimens for group II with the same brand of micro brush (Cotisen). Each group received a standardized polymerization process. The bonding surfaces of samples were then analyzed to determine the microbrush bristle remnants. An independent sample t-test was applied to compare the mean bristle remnants between the two groups. P value was set at 0.05 (at a 0.05 level of significance).

Results: Self-etch adhesive system had a greater number of microbrush bristle remnants than the total-etch adhesive system, but the difference was not statistically significant.

Conclusion: Irrespective of the different adhesive systems being used; microbrush bristle remnants were seen in both groups. Dentists should be cautious to avoid contamination of adhesive surfaces. The presence of bristle remnants might influence the shelf life of the restorations.

Key Words: Adhesive systems, bonding agent, microbrush bristle remnants, scanning electron microscope, self-etch adhesive system, total-etch adhesive system

Received: 07-Mar-2024
Revised: 05-Dec-2024
Accepted: 21-Jul-2025
Published: 24-Sep-2025

Address for correspondence:
Dr. Shraddha Padwal,
Department of Conservative Dentistry and Endodontics, D. Y. Patil Dental School, Lohegaon, Pune, Maharashtra, India.
E-mail: drshraddhapadwal@gmail.com

INTRODUCTION

The shelf life of restoration mainly depends on the adhesion between the tooth and restorative material.[1] Over the last few decades, numerous adhesive systems have been introduced to dentistry to create strong bonding to dentin and the restorative material. Dental adhesives are classified based on their generations or interaction with the smear layer.[2] However, etch and rinse, self-etch, and universal adhesive systems

Access this article online

Website: www.drj.ir
www.drjjournal.net
www.ncbi.nlm.nih.gov/pmc/journals/1480
DOI: 10.4103/drj.drj_112_24

How to cite this article: Padwal S, Shetty P, Dudulwar D, Keswani K, Lokhande V, Raje M. Microbrush bristle remnants on the bonding surface using different adhesive systems by scanning electron microscope: An *in vitro* study. Dent Res J 2025;22:36.

are majorly considered for enhancing the adhesion of composite restorations to the tooth.[3,4]

The adhesive seal may be compromised by the potential presence of any kind of residue (Powder from latex gloves, microbrush bristles, etc.).[5] During the bonding process, dental surface contamination can occur after the tooth surface has been etched and/or after the adhesive system has been applied.[6] As a result of contamination, the quality of the bond may be affected, causing micro leakage at the interface.[7]

As per the author's knowledge, the only study that has been conducted was by Berton *et al*.[5] in which he evaluated the presence of microbrush bristles fiber remnants on the bonding surfaces of teeth. Thus, this paper aimed to determine the presence of microbrush bristle remnants on the bonding surface using total-etch and self-etch adhesive systems.

MATERIALS AND METHODS

Ethics committee approval was taken before initiating the present study (Ref No. G-132/IECDYPDS/2023).

Inclusion and exclusion criteria

For the current experimental *in vitro* study, 12 caries-free permanent maxillary premolars were included in the study. Teeth were extracted for orthodontic reasons with no presence of microcracks or other anatomic defects on their surfaces and were selected by using a dental operating microscope (SEILER).[8]

Specimen preparation

After extraction, any remaining stains or debris were removed from the teeth using a manual curette (GDC). The teeth were kept in saline solution (NaCl 0.9%, Amanta) at a temperature of 4°C for a maximum of 1 month.[5] Samples were then decoronated to a thickness not more than 3 mm using a diamond disc (Frank Dental, Germany) at low speed attached to the straight handpiece of micromotor (Supreme Labo) [Figure 1]. The final thickness of each sample was confirmed using a digital Vernier Caliper (Precision 150 digital Caliper) with an accuracy of 0.001 mm.[9]

Study groups

The prepared specimens were divided into two groups;

- Group I (n = 6): Self-etch adhesive system
- Group II (n = 6): Total-etch adhesive system.

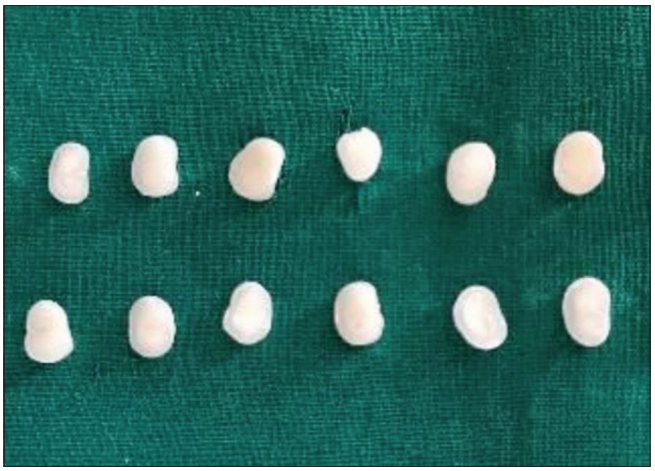


Figure 1: Specimen preparation.

Adhesion procedure

The bonding surfaces of all prepared specimens were rinsed using sterile distilled water for 10s and further dried with gentle air blow.[5] For both groups, the same brand of microbrush was used (Cotisen) and each micro-brush was disposed of after a single use. For group I, specimens underwent the application of Self etch adhesive bonding agent (Neofill, Orikam) using a microbrush applicator (Cotisen) and then photopolymerized for 40s[10] using a curing device (Woodpecker MINI S, 1000–1200 mW/cm^2) [Figure 2]. For group II, firstly the bonding surfaces of specimens were etched using etching gel (Prime Dental, Pvt. Ltd.) for 15 s[11] followed by rinsing and drying. Later, the specimens underwent the application of a total-etch adhesive bonding agent (Te-Econom Bond, Ivoclar Vivadent) using a microbrush applicator (Cotisen) and then photopolymerized for 40 s[10] using the same curing device [Figure 3].

Microscopic analysis

Before performing the analysis, all of the specimens were mounted on prefabricated aluminium stubs coated with double-sided carbon tape and examined under a scanning electron microscope (FESEM, Nova NanoSEM 450) with an accelerating voltage of 5Kv.[5]

STATISTICAL ANALYSIS AND RESULTS

Statistical analysis

Statistical analysis software (SPSS version 21.0) was used to tabulate the data for performing the statistical analysis. An independent sample t-test was applied to compare the mean bristle remnants among the two groups. P value was set at 0.05 (at a 0.05 level of significance).

Results

The present study was conducted to determine the microbrush bristle remnants on the bonding surfaces of teeth using different adhesive systems and techniques. The highest numbers of bristle remnants were seen in group I (12) [Figures 4 and 5] as compared to group II (8) [Figure 6 and Graph 1]. The mean number of bristle remnants is shown in [Table 1]. It was interpreted that the microbrush bristle remnants in the self-etch adhesive system were more than the total-etch adhesive system. No significant statistical difference (P = 0.99) was found between the two groups.

DISCUSSION

Recently, the complexity of restorative dentistry has increased with the variety of products being used.[12] The use of composites and adhesives in modern restorative dentistry allows the creation of a stronger bonding of the restorative material with dental tissue (dentin and enamel).[13] To achieve a long-lasting bonding between composites and the tooth tissues, numerous dental adhesive systems have been developed.[14] However, present adhesion strategies depend exclusively on the way dental adhesives react with the smear layer.[11]

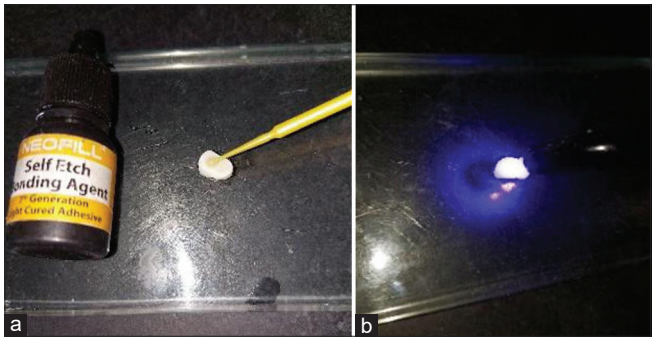


Figure 2: (a and b) Application of self-etch adhesive system on tooth surface followed by polymerization.

In the present study, etch and rinse and self-etch dentin bonding systems were used. Irrespective of the adhesive systems used, microbrushes were used to apply the priming adhesive solution to determine a more unified micromechanical bonding. According to the study's findings, the amount of microbrush remnants in the self-etch adhesive system was higher than in the total-etch adhesive system. This might be attributed to several reasons such as: different techniques of application of bonding agents on the tooth surface, the amount of force applied for the application, and the quality of the micro-brush being used. Moreover, SEM magnification for dental surfaces ranges between ×500 and ×5000, any remnant could have been missed, if detected as an artefact[7,8] in the total-etch adhesive system group.

The etch and rinse adhesive method mainly relies on the etching of enamel and dentin with phosphoric acid to remove the smear layer along with its attached smear plugs. Bonding agent application is done over the tooth surface without the application of much force, as etching has been already done.

Figure 3: (a-c) Etching and rinsing followed by application of total-etch adhesive system on the tooth surface and polymerization.

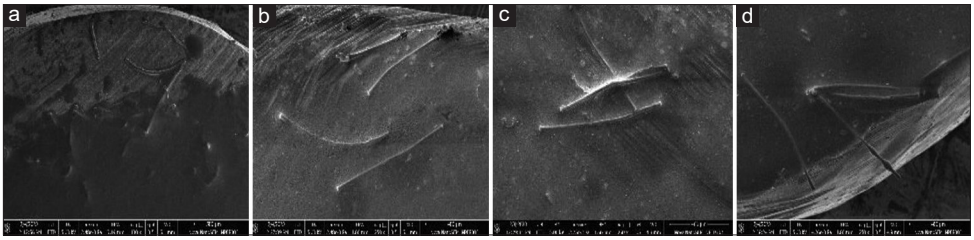
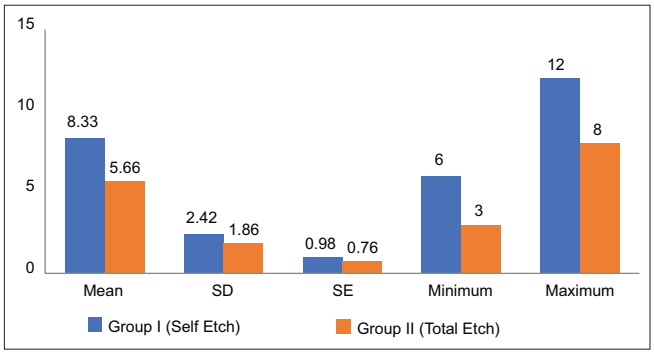


Figure 4: (a-d) Illustrative SEM images of the samples of group I (Teeth treated with Self-etch adhesive system).

However, self-etch adhesive systems do not employ a separate etching step as it does not remove the smear layer by their non-rinsing acidic primer. Instead, it integrates the smear layer residues into the adhesive interface.[2] Results in our study showed a higher number of bristle remnants in the self-etch adhesive system as compared to the total-etch adhesive system, as an active adhesive application was used for the self-etch adhesive system. In this method, the microbrush was rubbed with slight force on the tooth surface.[15] This could be one of the reasons for a higher number of bristle remnants in the Self-etch adhesive system due to enhanced force application and the stirring effect on the bonding surface.



Graph 1: Graph showing the number of bristle remnants. SD: Standard deviation; SE: Standard error.

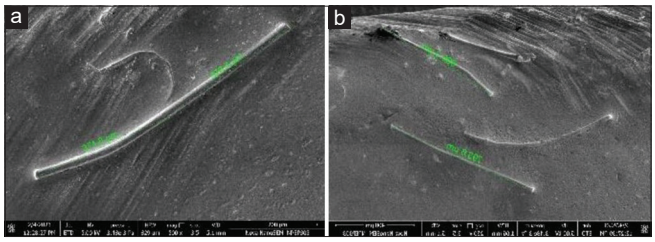


Figure 5: (a and b) Illustrative SEM images of the length of microbrush bristle remnants.

The utilization of disposable microbrushes for the bonding agent application on the surfaces of teeth is broadly propagated.[5] The utilization of microbrush during the insertion of fiber posts has been proven in the literature to create a more uniform micromechanical bond.[16] Surprisingly, there is very scarce information regarding the effect of bristle remnants on the tooth surface. Thus, the present *in vitro* study found that after the standardized application of bonding agents, microbrushes left residues on the adhesive surface after employing different adhesive systems and techniques. These remaining fibers may have an impact on several variables, including forces of adhesion, integrity of marginal seal or development of microgaps in the bonding layer.[5]

Nonetheless, additional research is required to evaluate the effects of these bristle remnants on the bonding surface of teeth and also to assess alternative methods for efficient bonding agent application that avoid contamination. Furthermore, the quality of the microbrush is to be considered when further studies will be conducted.

CONCLUSION

Irrespective of the adhesive systems used in the present study, the microbrush bristle remnants can be found over the tooth surface. Thus, the placement of composite restorations requires meticulous attention to procedure or it may fail prematurely.

However, dentists should be cautious to avoid contamination of the adhesive surface, as the presence of any remnants might influence the shelf life of restorations.

Financial support and sponsorship

Nil.

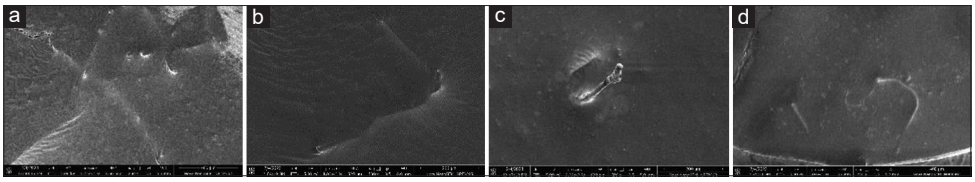


Figure 6: (a-d) Illustrative SEM images of the samples of group II (Teeth treated with total-etch adhesive System).

Table 1: Descriptive statistics of the number of bristles seen under the standard error of the mean in both groups

Groups	Mean (number of fibres)	SD	SE	Minimum (number of fibres)	Maximum (number of fibres)
Group I (Self-etch)	8.33	2.42	0.98	6	12
Group II (Total etch)	5.66	1.86	0.76	3	8

SD: Standard deviation; SE: Standard error

Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

REFERENCES

1. Shaffer SE, Barkmeier WW, Kelsey WP 3rd. Effects of reduced acid conditioning time on enamel microleakage. Gen Dent 1987;35:278-80.
2. Perdigão J, Araujo E, Ramos RQ, Gomes G, Pizzolotto L. Adhesive dentistry: Current concepts and clinical considerations. J Esthet Restor Dent 2021;33:51-68.
3. Pashley DH, Tay FR, Breschi L, Tjäderhane L, Carvalho RM, Carrilho M, *et al.* State of the art etch-and-rinse adhesives. Dent Mater 2011;27:1-16.
4. Rosa WL, Piva E, Silva AF. Bond strength of universal adhesives: A systematic review and meta-analysis. J Dent 2015;43:765-76.
5. Berton F, Rapani A, Zotti M, Stacchi C, Berton T, Porrelli D. Presence of micro-brush remnants on the adhesion surface: A microscopical analysis. J Dent 2022;127:104320.
6. Rusli, Effendy & Dennis, Dennis & Farahanny, Wandania. (2021). Influence of Saliva and Blood Contamination towards Class II Composite Restoration Tensile Bond Strength Using Universal Bonding Agent: An In-vitro Study. PalArch's Journal of Archaeology of Egypt/ Egyptology.
7. Tuncer S, Demirci M, Tekçe N, İşler SC, Uysal Ö. Effect of saliva contamination on shear bond strength and microleakage of one-bottle etch and rinse and self-etch adhesives: Scanning electron and confocal laser microscopic analyses. J Adhes Sci Technol 2014;28:525-45.
8. Mushtaq EA, Mathai V, Nair RS, Angelo JM. The effect of a dentin desensitizer on the shear bond strength of composite to dentin using three different bonding agents: An *in vitro* study. J Conserv Dent 2017;20:37-40.
9. Adarsh K, Sharma P, Juneja A. Accuracy and reliability of tooth length measurements on conventional and CBCT images: An *in vitro* comparative study. J Orthod Sci 2018;7:17.
10. Ferreira SQ, Costa TR, Klein-Júnior CA, Accorinte MD, Meier MM, Loguercio AD, *et al.* Improvement of exposure times: Effects on adhesive properties and resin-dentin bond strengths of etch-and-rinse adhesives. J Adhes Dent 2011;13:235-41.
11. Naganath, Meena & Jain, Niharika. (2011). Options for Dentin Bonding - Total Etch Or Self Etch?. International Journal of Contemporary Dentistry; Vol 2, No 2 (2011): Early Online Articles.
12. Schwartz RS, Fransman R. Adhesive dentistry and endodontics: Materials, clinical strategies and procedures for restoration of access cavities: A review. J Endod 2005;31:151-65.
13. Milia E, Cumbo E, Cardoso RJ, Gallina G. Current dental adhesives systems. A narrative review. Curr Pharm Des 2012;18:5542-52.
14. Sofan E, Sofan A, Palaia G, Tenore G, Romeo U, Migliau G. Classification review of dental adhesive systems: From the IV generation to the universal type. Ann Stomatol (Roma) 2017;8:1-17.
15. Saikaew P, Sattabanasuk V, Harnirattisai C, Chowdhury AF, Carvalho R, Sano H. Role of the smear layer in adhesive dentistry and the clinical applications to improve bonding performance. Jpn Dent Sci Rev 2022;58:59-66.
16. Vichi A, Grandini S, Ferrari M. Comparison between two clinical procedures for bonding fiber posts into a root canal: a microscopic investigation. J Endod. 2002 May;28(5):355-60. doi: 10.1097/00004770-200205000-00002. PMID: 12026918.