Comparative evaluation of clinical performance of two self-etch adhesive systems with total-etch adhesive system in noncarious cervical lesions: An in vivo study

Vasanta Ramesh Digole, Manjusha M. Warhadpande, Parag Dua, Darshan Dakshindas

Department of Dental Surgery and Oral Health Sciences, AFMC, Pune, 1Department of Conservative Dentistry and Endodontics, Government Dental College and Hospital, Nagpur, Maharashtra, India

Abstract

Background: The growing demands for esthetic restorations have stimulated intensive research in the field of adhesive dentistry. Dental adhesive systems are used to promote adhesion between composite resins and dental structure. In the fundamental principles of adhesion, the primary mechanism contributing to the formation of adhesion is micromechanical bonding between the restoration and the tooth. The bond strength of self-etching adhesives to dentin was found to be almost equal to that of total-etch adhesives. The aim of the present prospective, double-blind, randomized controlled clinical trial was to evaluate and compare the clinical performance of two self-etch adhesive systems with total-etch adhesive system in noncarious cervical lesions (NCCLs).

Materials and Methods: In each patient, three teeth were randomly assigned according to the adhesive system used to Group A (total-etch adhesive system), Group B (two-bottle self-etch adhesive system), and Group C (one-bottle self-etch adhesive system). The clinical efficacy of these adhesive systems was determined by evaluating the retention rate, marginal integrity, and postoperative sensitivity at the following three levels: baseline, 6 months, and 18 months by following the Modified USPHS criteria introduced by Vanherle et al.

Results: In the present study, the retention rate at 18 month in Group A, Group B, and Group C of 96%, 92%, and 92% was observed, respectively. A marginal integrity at 18 months was 88%, 80%, and 84% for Group A, Group B, and Group C, respectively. Postoperative sensitivity at 18 months was 16%, 12%, and 12% for Group A, Group B, and Group C, respectively.

Conclusion: The clinical performance of total-etch and self-etch adhesive systems in NCCLs did not differ significantly with regard to the evaluated parameters – retention, marginal integrity, and postoperative sensitivity.

Keywords: Adhesives; bonding agent; marginal integrity; noncarious cervical lesions; retention; self-etch; total-etch and sensitivity

INTRODUCTION

The achievement of high-strength, durable bonds between tooth structure and restorative materials has been a long-term goal of the dental profession. Successful attempts to bond to dentin have been extensively studied, but the dentin substrate differs from enamel, as it presents more organic contents, an increased presence of fluid inside the dentinal tubules, a smear layer, and an inherent surface

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: 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. J Conserv Dent 2020;23:190-5.
Current adhesion strategies involve two trends: the total-etch bonding technique characterized by the complexity of its components and bonding procedures, and self-etching systems, following a trend toward simplification. Adhesive systems can be classified based on how they react with the smear layer. Three mechanisms of adhesion are currently in use with modern adhesives, as follows: etch-and-rinse adhesives, which remove the smear layer and superficial hydroxyapatite through etching with a separate acid gel; self-etch adhesives, which make the smear layer permeable without removing it completely; and glass ionomer adhesives, which are self-adhesive to tooth tissues.

Total-etch adhesive systems, which remove the smear layer with phosphoric acid and combine the functions of primer and adhesive in one bottle, have been widely used. Although long-term clinical success has been achieved with total-etch systems, the demand for simplified application has increased, resulting in the development of self-etching adhesive systems. The bonding mechanism of self-etching adhesive systems is based on the simultaneous etching and priming of enamel and dentin without rinsing, forming a continuum in the substrate and incorporating smear plugs into the resin tags. A self-etch approach involves either a one- or two-step application procedure. Noncarious cervical lesions (NCCLs) were used as clinical models to evaluate the performance of adhesive systems. The aim of the present prospective, double-blind, randomized controlled clinical trial was to evaluate and compare the clinical performance of two self-etch adhesive systems with total-etch adhesive system in NCCLs.

MATERIALS AND METHODS

This clinical study was undertaken after gaining approval from the institutional ethics committee with the certificate no. GCACN/SS/PG/Ethic.Com.Meet/143/2013 dated January 16, 2014.

Sample size calculation

With the power of study 80%, significance level $P < 0.05$, and 20% difference in terms of retention to be detected between the three groups at the end of 18 months, the sample size was 25 teeth in each group (EPI sample size calculation software, CDC, USA). The inclusion criteria consisted of patients aged 20–50 years who had at least three NCCLs with cervico-incisal height of 1–2 mm and average depth of 1 mm. The selected teeth were having healthy periodontium and had antagonist teeth. Patients with extremely poor oral hygiene, severe or chronic periodontitis, or heavy bruxism habits were excluded from the study. The other exclusion criteria were nonvital teeth with clinical and radiographic signs of caries and periapical lesions.

The purpose of the study was explained to the selected patients, and a written informed consent was obtained. In each patient, three teeth were randomly assigned according to the adhesive system used to Group A, total-etch adhesive (Adper™ Single Bond 2; 3M™ ESPE™), Group B, two-bottle self-etch adhesive (one coat self-etching bond, Coltene/Whaledent Inc., Mahwah, NJ, USA), and Group C, one-bottle self-etch adhesive system (Single-Bond Universal Adhesive; 3M ESPE) by using the lottery method of randomization.

Restorative procedure

All the NCCLs were restored by one operator. Shade selection was performed using the Vita Classical shade guide (Vident, Brea, CA, USA). Gingival tissue retraction was achieved using a retraction cord (No. 0, 00, and 000 Ultrapak, Ultadent Products, Inc., South Jordan, UT, USA.) to achieve isolation from fluids, to improve access and visibility, and to prevent abrasion of gingival tissues during tooth preparation. The teeth were then isolated using a rubber dam and appropriate retainers such as No. 212 retainer (Hygenic, Coltene/Whaledent Inc., Mahwah, NJ, USA). A 0.5-mm bevel was prepared on the occlusal margin of the lesion on the enamel using a flame-shaped diamond bur (F0-22, MANI INC., Tochigi, Japan). The adhesives were applied to the lesions as per the manufacturer’s instructions. The composite resin (Filtek Z350 ET 3M ESPE) was placed in small increments and cured using a light-curing unit (Allure Light Cure Unit, Prime Dental Products Pt Ltd, Thane, Maharashtra, India). After curing, the restorations were finished with fine-grit diamond burs and polished with super-snap mini kit (finishing and polishing kit, Shofu Inc. Kyoto, Japan). Digital images of the lesions were taken to help with the evaluation before and after the restoration at baseline and 6-month and 18-month recall visits [Figures 1 and 2].

Clinical evaluation

The clinical efficacy of these adhesive systems was determined by evaluating the retention rate, marginal integrity, and postoperative sensitivity. The clinical evaluations were performed at three levels: baseline (1 week later), 6 months, and 18 months by following the Modified USPHS criteria introduced by Vanherle et al. [Table 1]. The restorations were evaluated by two experienced and calibrated examiners who were not involved in the placement of the restorations and therefore blinded to the group assignment. Both the examiners evaluated all the restorations once and independently. When disagreements occurred during the evaluations, the examiners had to
reach a consensus before the patient was dismissed. Clinical evaluation of each restoration was performed with a mouth mirror, an explorer, and a UNC-15 periodontal probe (Hu-Friedy, Chicago, IL, USA). All parameters during evaluation were recorded using a data-recording sheet. The data were then tabulated and statistically analyzed.

Statistical analysis
SPSS v 16.0, IBM Corporation, USA was used for data analysis. Frequency distribution of categorical data was calculated. Chi-square test was used for comparison of baseline characteristics between the experimental groups. Freidman’s test was used for comparison of marginal integrity, retention of restoration, and postoperative sensitivity in each experimental group at baseline, 6- and 18-month follow-up. Kruskal–Wallis test was used for comparison of marginal integrity, retention of restoration and postoperative sensitivity at each of the baseline and 6-and 18-month follow-ups between the three experimental groups. Mann–Whitney U-test was used as post hoc test. P < 0.05 was considered statistically significant.

RESULTS
No statistically significant differences in retention rate and marginal integrity at baseline and 6-month and 18-month recall visit were observed between the three adhesive systems (P > 0.05) [Graphs 1 and 2]. There was a significant difference in the preoperative and postoperative sensitivity in all the three groups at 18 months [Graph 3]. Overall clinical success rate for three different adhesive systems showed that there was no statistically significant difference at 18-month recall visit (P > 0.05).
**DISCUSSION**

The restoration of NCCLs, has long been the primary clinical method for testing the adhesive behavior of restorative materials, since being incorporated into the former American Dental Association (ADA) acceptance program for dentin and enamel adhesive materials in 1994. NCCLs are slowly progressing clinical conditions with multiple etiologies that offer unique challenges to adequate dental restoration. In the evolution of adhesive technology from one type to the other, the impetus has been to improve bond strength while simplifying application procedures.

In the present study, baseline matching related to the independent variables was done so as to avoid their influence on treatment outcomes. Preoperative and postoperative sensitivity was assessed by a combination of thermal and evaporative stimulation. A strong air-blast from a three-way dental syringe was directed to the exposed cervical area for 5 s at a distance of 1 cm and at the right angle to the buccal surface of the assigned tooth, while the adjacent teeth were isolated with cotton rolls. Compared with tactile stimulation, evaporative stimulation is thought to be a more reproducible method for assessing dentin hypersensitivity. All participants received restorations composed of all the three adhesives to minimize the influence of the oral environment on the restorative materials. The beveled technique was used because there is not enough evidence to support the beveled technique over nonbeveled for NCCLs over longer periods of time. To minimize the effects of mode of curing and to increase the potential for analysis of failures and comparison of studies, all the composite resin restorations were light cured using light-emitting diode light-curing device (Allure pdp). It was used with continuous mode for 30 s and the intensity of the device was monitored as per the manufacturer’s instructions. In the present study, inter-rater agreement for both the examiners had a kappa agreement rating >85%.

**Table 1: Criteria for evaluation of retention, marginal integrity, and postoperative sensitivity**

| Clinical parameter | Score | Definition | Evaluation method |
|--------------------|-------|------------|------------------|
| Retention          | Alpha | The restoration is completely retained | Visual inspection with an explorer |
|                    | Bravo | Bravo: The restoration is partially retained | |
|                    | Charlie | Charlie: The restoration is completely lost | |
| Marginal integrity | Alpha | The explorer does not stick when it is passed from the restoration surface to the tooth, or, if the explorer sticks, there is no visible fracture along the restoration margin | Visual inspection with an explorer |
|                    | Bravo | The explorer sticks, and there is no clear and visible fracture where the explorer enters, indicating that the margin of the restoration is not adapted closely with the structure of the tooth. The dentin and/or the base are not exposed, and the restoration has no mobility |
|                    | Charlie | The explorer enters a mass defect of the structure that extends to the dento‑enamel junction | |
|                    | Delta | The restoration is totally or partially fractured, mobile, or missing | |
| Postoperative sensitivity | Alpha | No postoperative sensitivity | Blowing a stream of compressed air for 5 s |
|                    | Bravo | Postoperative sensitivity is present | |

**Table 2: Distribution of baseline characteristics between the experimental groups**

| Arch distribution | Group A (%) | Group B (%) | Group C (%) | Total (%) |
|-------------------|-------------|-------------|-------------|-----------|
| Maxillary         | 20 (80)     | 19 (76)     | 19 (76)     | 58 (77.33) |
| Mandibular        | 5 (20)      | 6 (24)      | 6 (24)      | 17 (22.66) |
| Tooth type        |             |             |             |           |
| Incisor           | 1 (4.0)     | 1 (4.0)     | 1 (4.0)     | 3 (4.0)   |
| Canine            | 5 (20.0)    | 5 (20.0)    | 4 (16.0)    | 14 (18.66) |
| Premolars         | 18 (72.0)   | 17 (68.0)   | 18 (72.0)   | 53 (70.66) |
| Molars            | 1 (4.0)     | 2 (8.0)     | 2 (8.0)     | 5 (6.66)  |

**Preoperative sensitivity**

| Yes | 17 (68) | 18 (72) | 18 (72) | 53 (70.66) |
| No  | 8 (32)  | 7 (28)  | 7 (28)  | 22 (29.33) |

**Shape of NCCLs**

| Wedge shaped | 18 (72) | 18 (72) | 18 (72) | 54 (72) |
| Saucer shaped| 7 (28)  | 7 (28)  | 7 (28)  | 21 (28) |

NCCLs: Noncarious cervical lesions

**Evaluation of retention rate**

The retention of restoration is the key criterion by which clinical efficacy of the applied adhesive system and restorative material is estimated. This is the most reliable diagnostic criterion and the most obvious sign of a failed restoration because it does not depend on the examiner’s subjective assessment. The guidelines for dentin and enamel adhesive materials put forth by the ADA suggest that the retention rate at 6 months must be at least 95% for provisional acceptance, whereas the retention rate at 18 months must be at least 90% for full acceptance.

In the intragroup comparison of retention rate, no significant difference was detected when baseline and 6-month and 18-month data were compared within group (P > 0.05). Intergroup comparison of retention rate also showed no significant difference [Graph 1]. For provisional acceptance, all the three adhesive systems fulfilled the guidelines for dentin and enamel adhesive materials put forth by the ADA. The findings of the present study were in accordance to a clinical trial by Burgess and
Sadid-Zadehr. In their clinical trial, retention for Single Bond Plus, Scotchbond SE, and Easy Bond at 24 months was 97%, 90%, and 95%, respectively, showing statistically nonsignificant difference.[7]

The high retention rates in the present study might be related to the application of two coats of adhesives, as the application of two coats has been found to increase bonding efficacy.

Consecutive coats can promote removal of water and solvent and allow more resin uptake into the collagen fibril network.[11]

Failure rates of adhesives were reported by van Dijken and Pallesen (2011), which were 7.7% in the one-step self-etch adhesive group and 5.6% in the two-step etch-and-rinse adhesive group. The contributing factor for failure could be the highly hydrophilic nature of one-step self-etch adhesives due to which they attract water and increase the potential for degradation.[12]

**Evaluation of marginal integrity**

Marginal integrity provides information about the quality of the restoration placed by the clinician as well as the material itself with regard to its adaptability to the cavity margins.[13] The ADA guideline for adhesives recommends <10% Charlie for marginal integrity at 18 months.[7]

Intragroup comparison of marginal integrity shows that all groups were similar to one another, but lack of marginal integrity was increasingly seen in the later recall periods. It was observed that in Group B and Group C, there was a slightly more deterioration in marginal integrity of restorations at 18-month recall. This could be explained by the more susceptibility to microleakage in enamel and dentin because of lower bond strength. This is in accordance with an *in vitro* study by Frankenberger and Tay who evaluated the effect of thermo mechanical loading on marginal quality of bonded composite restorations in self-etch and total-etch adhesives and observed that after thermo-mechanical loading etch-and-rinse adhesives exhibited significantly higher percentages of gap-free margins compared with two-step self-etch and one-step self-etch adhesives.[14] The reasons for the failure of marginal adaptation might have been thermal and mechanical stresses in the oral environment, viscoelastic property of the restorative material, water sorption and hydrolysis along the tooth–restorative interface, and unique stress patterns at the cervical margin of the tooth.[11]

Intergroup comparison of marginal integrity showed no significant difference when baseline and 6-month and 18-month data were compared between the groups [Graph 2]. The adhesives used in this clinical trial meet the guidelines for marginal quality of composite resin restorations. These results demonstrate that the tested adhesive systems showed good marginal integrity during the evaluated period, which is desirable, because restorations with deteriorating margins are more likely to fail than restorations with ideal margins.[15]

While examining adhesive systems in their extensive 1-year clinical study, Van Merbeek *et al.* (1996) indicated that failure in all tested adhesive systems showed inadequate margin closure.[10]
Evaluation of postoperative sensitivity
Postoperative sensitivity is usually a secondary end point in clinical studies. The ability of the adhesive layer to coat and bond to the tooth structure plays a key role in reducing sensitivity. Sensitivity improved significantly for all groups from preoperative conditions to 1 week after insertion and remained stable thereafter [Graph 3].

In the present study, all the three adhesives performed the same with regard to postoperative sensitivity. This is in accordance to Perdigão et al. who demonstrated similar findings that self-etch and total-etch adhesives did not differ with regard to postoperative sensitivity.[16] According to Van Landuyt et al., the reduction of postoperative sensitivity can be explained by the protective effect of the restoration.[15]

In this clinical study, the overall clinical performance did not differ between the three adhesives at 18 months. However, considering the limitations of the present study, further studies with large sample size with long-term follow-up are required.

CONCLUSION
Restoration of NNCLs with the one-step and two step self-etching adhesive can be an appropriate alternative to the more complicated adhesives systems. Based on the results and within the limitations of the present study, it can be concluded that, the clinical performance of total-etch and self-etch adhesive systems in NNCLs did not differ significantly with regard to the evaluated parameters – retention, marginal integrity, and postoperative sensitivity.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES
1. Hegde MN, Manjunath J. Bond strength of newer dentin bonding agents in different clinical situations. Oper Dent 2011;36:169-76.
2. Pasley DH, Tay FR, Breschi L, Tjaderhane L, Carvalho RM, Carrilho M, et al. State of the art etch-and-rinse adhesives. Dent Mater 2011;27:1-6.
3. Yazici AR, Celik C, Ozgünaltay G, Dayangac B. Bond strength of different adhesive systems to dental hard tissues. Oper Dent 2007;32:166-72.
4. Moosavi H, Kimyai S, Forghani M, Khodadadi R. The clinical effectiveness of various adhesive systems: An 18-month evaluation. Oper Dent 2013;38:134-41.
5. Vanherle G, Verschueren M, Lambrechts P, Braem M. Clinical investigation of dental adhesive systems. Part I: An in vivo study. J Prosthet Dent 1986;55:157-63.
6. Perdigão J, Dutra-Corrêa M, Saraceni CH, Ciaramicoli MT, Kiyam VH, Queiroz CS. Randomized clinical trial of four adhesion strategies: 18-month results. Oper Dent 2012;37:3-11.
7. Burgess JO, Sadid-Zadehr R. Clinical evaluation of self-etch and total-etch adhesive system in non-carious cervical lesions: A two-year report. Oper Dent 2013;38:477-87.
8. Sgolastra F, Petrucci A, Severino M, Gatto R, Monaco A. Lasers for the treatment of dentin hypersensitivity: A meta-analysis. J Dent Res 2013;92:492-9.
9. Schroeder M, Reis A, Luque-Martinez I, Loguericio AD, Masterson D, Maia LC. Effect of enamel bevel on retention of cervical composite resin restorations: A systematic review and meta-analysis. J Dent 2015;43:777-88.
10. Stojanac IL, Premovic MT, Ramic BD, Drobac MR, Stojin IM, Petrovic LM. Noncarious cervical lesions restored with three different tooth-colored materials: Two-year results. Oper Dent 2013;38:12-20.
11. Krithikadatta J. Clinical effectiveness of contemporary dentin bonding agents. J Conserv Dent 2010;13:173-83.
12. Perdigão J, Kose C, Mena-Serrano AP, De Paula EA, Tay LY, Reis A, et al. A new universal simplified adhesive: 18-month clinical evaluation. Oper Dent 2014;39:113-27.
13. Hickel R, Roulet JF, Bayne S, Heintze SD, Mijor IA, Peters M, et al. Recommendations for conducting controlled clinical studies of dental restorative materials. Science Committee Project 2/98–FDI world dental federation study design (Part I) and criteria for evaluation (Part II) of direct and indirect restorations including onlays and partial crowns. J Adhes Dent 2007;9 Suppl 1:121-47.
14. Frankenberger R, Tay FR. Self-etch vs etch-and-rinse adhesives: Effect of thermo-mechanical fatigue loading on marginal quality of bonded resin composite restorations. Dent Mater 2005;21:397-412.
15. Van Landuyt KL, Peumans M, Fieuws S, De Munck J, Cardoso MV, Ermis RB, et al. A randomized controlled clinical trial of a HEMA-free all-in-one adhesive in non-caries cervical lesions at 1 year. J Dent 2008;36:847-55.
16. Perdigão J, Geraldeli S, Hodges JS. Total-etch versus self-etch adhesive: Effect on postoperative sensitivity. J Am Dent Assoc 2003;134:1621-9.