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Research Article

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Effect of dentin roughening and type of composite material on the restoration of non-carious cervical lesions: an *in vivo* study with 18 months of follow-up

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Conflict of Interest
No potential conflict of interest relevant to this article was reported.

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Conceptualization: Singla R, Gill GS. Data curation: Verma S, Jain N. Formal analysis: Singla R, Gill GS, Jain N. Investigation: Verma

ABSTRACT

Objectives: The purpose of this study was to evaluate the impact of dentin roughening and the type of composite resin used (either bulk-fill flowable or nanohybrid) on the restoration of non-carious cervical lesions (NCCLs) with an 18-month follow-up period.
Materials and Methods: This prospective split-mouth study included 36 patients, each with a minimum of 4 NCCLs. For each patient, 4 types of restorations were performed: unroughened dentin with nanohybrid composite, unroughened dentin with bulk-fill flowable composite, roughened dentin with nanohybrid composite, and roughened dentin with bulk-fill flowable composite. A universal bonding agent (Tetric N Bond Universal) was applied in self-etch mode for all groups. The restorations were subsequently evaluated at 6, 12, and 18 months in accordance with the criteria set by the FDI World Dental Federation. Inferential statistics were computed using the Friedman test, with the level of statistical significance established at 0.05.
Results: The 4 groups exhibited no significant differences in relation to fracture and retention, marginal staining, marginal adaptation, postoperative hypersensitivity, or the recurrence of caries at any follow-up point.
Conclusions: Within the limitations of the present study, over an 18-month follow-up period, no significant difference was present in the clinical performance of bulk-fill flowable and nanohybrid composite restorations of non-carious cervical lesions. This held true regardless of whether dentin roughening was performed.

Keywords: Bulk-fill composite; Nanohybrid composite; Non-carious cervical lesion; Dentin roughening

INTRODUCTION

Non-carious cervical lesions (NCCLs) are defects characterized by the pathological loss of tooth substance at the cemento-enamel junction, without the involvement of microorganisms or inflammatory processes. These lesions, which range from shallow and saucer-shaped to deep and wedge-shaped, are observed on the gingival third of the tooth [1]. With an average prevalence of approximately 46.7% globally and 62% in Asia, NCCLs constitute a substantial portion of lesions necessitating restorative treatment [2]. These lesions must be restored to

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prevent tooth sensitivity, plaque retention, and caries, as well as to preserve the structural integrity of the tooth and the vitality of the pulp.

However, research has reported a loss of retention of up to 50% in NCCL restorations [3]. This has been ascribed to a variety of anatomical factors and technical challenges associated with these restorations. These obstacles include the non-retentive shape of NCCLs, the presence of a hypermineralized superficial layer, continuous flexure in the cervical area, and difficulty maintaining isolation [4,5]. The reduced permeability of hypermineralized dentin complicates the establishment of a hybrid layer. Several procedures have been suggested to make the dentin surface more amenable to bonding, such as gentle to vigorous rubbing of adhesive, the use of 17% ethylenediaminetetraacetic acid to modify the surface, and the roughening of the dentin using a diamond bur [3,6-15]. Some research has suggested that dentin roughening, which removes the superficial hypermineralized layer, significantly enhances restoration retention rates in NCCLs [3,9-11]. However, other studies have reported no significant impact of dentin roughening [6-8,16]. Therefore, this issue warrants further exploration.

Another challenge associated with NCCLs is the ongoing flexure of the tooth in the cervical area during mastication. This flexure can lead to restoration dislodgement due to a mismatch between the elastic moduli of the restorative material and the tooth. This makes the choice of material crucial for NCCL restoration [4]. It has been proposed that materials with an elastic modulus comparable to that of dentin should be preferred for the restoration of NCCLs. When deformed under load or occlusal stress, such materials can flex in a manner similar to the tooth structure [17,18]. Currently, composite resin systems are frequently used for NCCL restoration due to their conservative tooth preparation, ease of application, bonding, aesthetics, and repairability. Two such systems are nanohybrid composites (NHCs) and bulk-fill flowable (BFF) composites. While NHCs offer the benefits of polishability and strength, BFF composites provide advantages such as reduced clinical time (due to a 4-mm depth of cure), superior handling properties, and lower risk of bubble entrapment compared to the incremental build-up required with NHCs [19]. Two *in vivo* studies have compared NHCs and BFF composites in the restoration of NCCLs, but they revealed no significant clinical differences between the materials [19,20]. However, an *in vitro* study indicated reduced gap formation and improved stress distribution around the cavity margin with BFF composites in class V restorations [21].

No research to date has examined the impact of dentin roughening on the restoration of NCCLs using NHC and BFF composite resins. As such, this *in vivo* study was undertaken to assess the effect of dentin roughening and the type of composite resin (either BFF or nanohybrid) on the restoration of NCCLs. The study was conducted over a follow-up period of 18 months and applied the FDI World Dental Federation (FDI) criteria for evaluation. The null hypothesis proposed for this study was that neither dentin roughening nor the type of composite resin (BFF or NHC) would influence marginal staining, fracture and retention, marginal adaptation, postoperative sensitivity, or secondary caries in the restoration of NCCLs over the 18-month follow-up period.

MATERIALS AND METHODS

Study design

This prospective, double-blind (that is, with blinding of both patients and calibrated examiners), split-mouth, randomized clinical trial was conducted in the Department of

Conservative Dentistry and Endodontics, in accordance with the Consolidated Standards of Reporting Trials (CONSORT) guidelines. The protocol for the present study was reviewed and approved by the Institutional Ethics Committee of JCD Dental College (JCDV/DC/19/1740). The clinical trial was registered in the clinical registry (www.ctri.nic.in) under the registration number CTRI/2021/08/035863. All participants provided written informed consent after being fully informed about the nature, objectives, risks, benefits, and alternatives of the clinical procedure. This included the option to withdraw from the trial at any stage without repercussions.

Patient selection

Patients were randomly selected from the regular outpatient clinic of the Department of Conservative Dentistry and Endodontics. Evaluations were performed using a mouth mirror, an explorer, and a periodontal probe. Two trained postgraduate students screened the patients based on the following criteria.

Regarding inclusion criteria, the study included patients who provided informed consent, were in good health, were over 18 years old, and had a minimum of 4 NCCLs (in 4 different teeth) that required restoration. Additionally, these patients had to have acceptable oral hygiene, as indicated by a score of 0.7 to 1.6 on the Oral Hygiene Index-Simplified, and at least 20 teeth in occlusion. The lesions in question needed to be non-retentive, to be deeper than 2 mm, and to involve both the enamel and dentin of vital teeth without any mobility.

For exclusion criteria, this study did not include patients who had grossly carious teeth or teeth that served as abutments for fixed or removable prostheses. Additionally, individuals with extremely poor oral hygiene, severe or chronic periodontitis, or parafunctional habits such as heavy bruxism were excluded. Those with a history of periodontal surgery, who were currently undergoing orthodontic treatment, or who did not provide informed consent were also excluded from the study.

In total, 550 patients were analyzed. Of these, 36 patients were selected in accordance with the inclusion criteria.

Sample size determination

The sample size for the current study was determined based on data derived from a previous study conducted by Loguercio *et al.* [6]. The data were analyzed using G*Power (version 3.1.9.7; University of Düsseldorf, Düsseldorf, Germany). To maintain the study's power at 80% and the level of significance at 5%, a minimum sample size of 32 patients was calculated as adequate. Considering a potential dropout rate of 10%, the total sample size for the study was set at 36.

Randomization

Randomization was conducted on an intra-individual basis. That is, for each patient, 4 teeth were selected for the study. The type of restoration (BFF composite or NHC) and procedure (dentin roughening) to be performed were determined randomly. This randomization was carried out using the chit method. The groups were indicated on 4 cards, and for each tooth in every patient, a single card was drawn. The treatment was then performed according to the group indicated on the card. Both the patients and the 2 evaluators were kept unaware of the roughening procedure and the type of composite material assigned to each tooth. However, operator blinding was not possible, as all procedures were performed by a single operator.

The 4 groups into which the teeth were randomly divided were as follows:

Group I: Unroughened dentin with NHC
Group II: Unroughened dentin with BFF composite
Group III: Roughened dentin with NHC
Group IV: Roughened dentin with BFF composite

Clinical procedure

1. All patients selected for this study received oral prophylaxis. This was followed by cleaning using a suspension of pumice and water in a rubber cup, performed 1 week prior to the restoration.
2. For 3-dimensional assessment of the cervical lesions, elastomeric impressions (Affinis; Coltène/Whaledent AG, Altstätten, Switzerland) were made, and models were subsequently cast. The following characteristics of the NCCLs were recorded: shape, cervico-incisal length of the lesion, degree of sclerotic dentin, presence of antagonist, presence of preoperative sensitivity, and tooth and arch distribution. Shape was defined as the degree of the angle between the occlusal and gingival walls on the stone model, measured using a divider and protractor [22].
3. The dimensions of the cavity, measured in millimeters for height, width, and depth, were observed and documented, along with the presence of attrition facets. The depth of the lesion was assessed using a graduated probe. The degree of sclerotic dentin was evaluated according to the Swift criteria [23], as follows. A score of 1 indicated no sclerosis, with the dentin appearing light yellow or whitish and showing minimal discoloration. A score 2 was assigned when sclerosis was present in more than 1% but less than 50% of the dentin. A score of 3 was applied when sclerosis was present in more than 50% but less than 4% of the dentin, and a score of 4 was given when the dentin was dark yellow or discolored (brownish) and exhibited marked translucency or transparency.
4. Preoperative sensitivity was evaluated by administering compressed air for a duration of 10 seconds from a 3-way syringe positioned 2 cm from the tooth surface, in conjunction with an explorer. These features were documented to facilitate the comparison of baseline attributes of the dentin cavities across the experimental groups.
5. The teeth were anesthetized via infiltration, utilizing a 2% lignocaine solution that contained 1:200,000 adrenaline.
6. A rubber dam and retraction cord were positioned. Following this, the lesion underwent restorative treatment in accordance with the randomly assigned group (The details are described below).
7. All 4 restorations were completed at a single appointment for each patient.

Group I

A single layer of universal adhesive (Tetric N-Bond Universal; Ivoclar Vivadent, Schaan, Liechtenstein) was carefully applied to the entire surface of the enamel and dentin, in accordance with the manufacturer's recommendations. This process took approximately 20 seconds. Subsequently, a gentle air stream was used for 5 seconds to uniformly distribute the adhesive. This was followed by light curing for 10 seconds at an intensity of 1,100 mW/cm^2 (Bluephase N® M; Ivoclar Vivadent). The lesion was then restored using NHC (Tetric N-Ceram; Ivoclar Vivadent), applied in 2-mm increments and cured for 20 seconds.

Group II

The adhesive was applied in a manner like that used in group I. The lesion was then restored

using BFF composite (Tetric N-Flow; Ivoclar Vivadent) in a single increment. Light curing was subsequently performed for 20 seconds.

Group III

Prior to application of the universal adhesive, the dentin was roughened with a No. 2 diamond bur (Mani Inc., Tochigi, Japan) for 5 seconds at high speed, with water cooling employed. No attempt was made to roughen the enamel surfaces.

A fresh bur was utilized for each patient, corresponding to 4 restorations per bur. Then, the lesion was treated with NHC, employing the same method as used in group I.

Group IV

All steps for this group were similar to those in group III, with the exception that the lesion was restored with BFF rather than NHC.

8. In all groups, restorations were completed immediately using fine and extra-fine diamond burs (Mani Inc.), with constant water cooling applied throughout the process.

Follow-up

Final polishing was completed 1 week after restoration. The baseline analysis of these restorations was performed and recorded using FDI criteria [24], as assessed by 2 calibrated examiners. Patients were subsequently recalled at intervals of 6, 12, and 18 months for further analysis based on the FDI criteria (**Figure 1**).

Examiner calibration

Two experienced examiners, each with over 5 years of experience, were calibrated using images of NCCL restorations that were unrelated to this study. The agreement between examiners was evaluated using the kappa statistic. Following calibration, both examiners

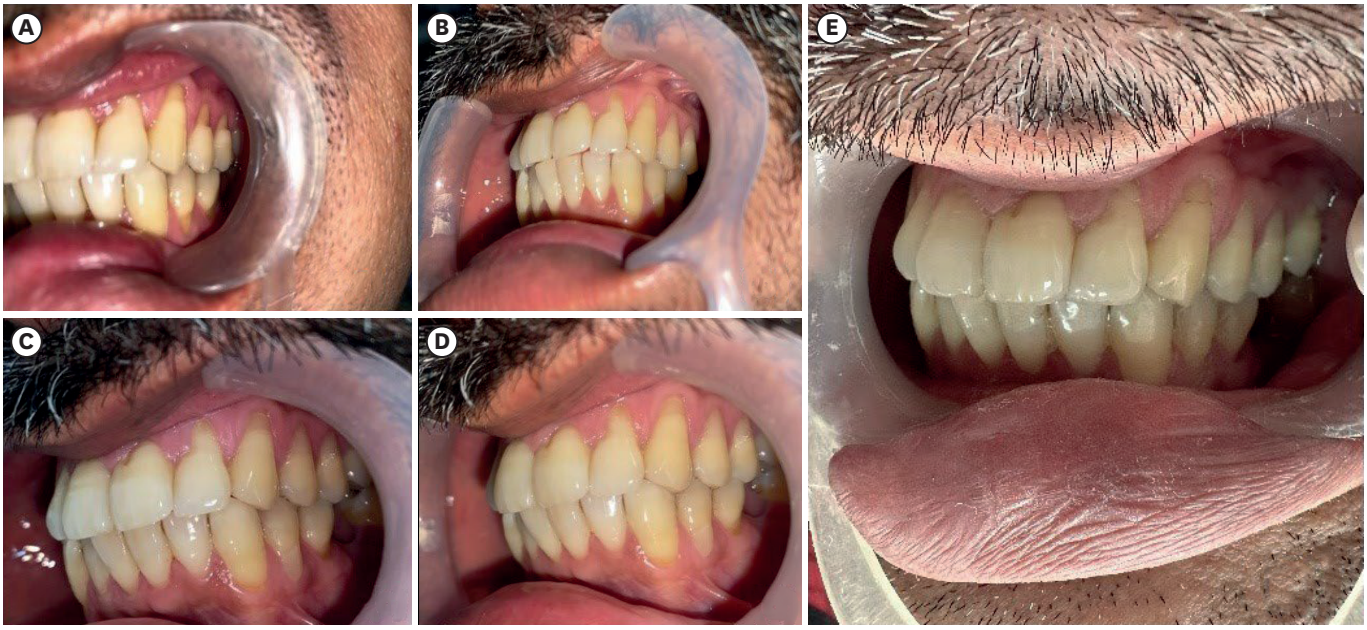

Figure 1. Clinical photographs of a patient having cervical lesions in #23, #24, #25, and #34 (FDI notation) during study period. Representative photographs taken (A) preoperatively and (B) at baseline (immediately postoperative), (C) 6 months, (D) 12 months, and (E) 18 months postoperatively.

evaluated the study restorations at baseline and at each subsequent follow-up point. At all times, the examiners were blinded to the study group to which each tooth belonged. The scores for each restoration were compared at the conclusion of the examination session. In instances of disagreement, a consensus score was reached by the examiners and recorded as the final score.

Statistical analysis

The data were analyzed using SPSS version 21 (IBM Corp., Armonk, NY, USA). All variables were categorical; as such, they were summarized using frequency and mean (standard deviation). Given that all types of test interventions were administered to all study participants, the Friedman test was employed to compare the 4 groups. Inferential statistics were also conducted using the Friedman test. The threshold for statistical significance was established at 0.05.

RESULTS

The study incorporated a total of 36 patients (144 restorations). However, 8 patients were lost to follow-up, leaving 28 patients (103 restorations) to be analyzed at the conclusion of the study period, as depicted in the CONSORT flowchart in **Figure 2**. The inter-examiner agreement, as measured using the kappa statistic, was 0.84 at baseline and 0.85, 0.86, and 0.86 at the 6, 12, and 18-month marks, respectively.

Most of the patients in the study were male (30 of 36), and the predominant age group was over 40 years (29 of 36). The preoperative characteristics of the lesions, such as shape, cervico-incisal size, degree of sclerotic dentin, presence of antagonist, preoperative sensitivity, and tooth and arch distribution, are detailed in **Table 1**. Preoperatively, grade 3 sclerotic dentin was significantly more prevalent in group I than in the other groups (p = 0.024). The teeth were evaluated according to FDI criteria at baseline, and again at 6, 12, and 18 months, with the results presented in **Table 2**. If restorations were lost (retention loss), no other criteria could be evaluated for those particular teeth.

No significant difference was observed among the 4 groups regarding fracture and retention marginal staining, marginal adaptation, postoperative hypersensitivity, or the recurrence of caries at any follow-up point. The line diagram depicting the mean FDI scores for fracture and retention is presented in **Figure 3**.

DISCUSSION

In this study, we evaluated the effect of dentin roughening and the type of restorative material used in the restoration of NCCLs. The null hypothesis was that no difference would be observed between BFF composite and NHC, as used in NCCL restorations, regardless of whether dentin roughening was performed. According to the findings, no statistically significant difference was found between the 2 materials in any of the parameters evaluated (as per the FDI standards); thus, the null hypothesis was not rejected.

Given that no other study has concurrently examined the impact of dentin roughening and the type of restorative material, the findings of this study cannot be directly compared with

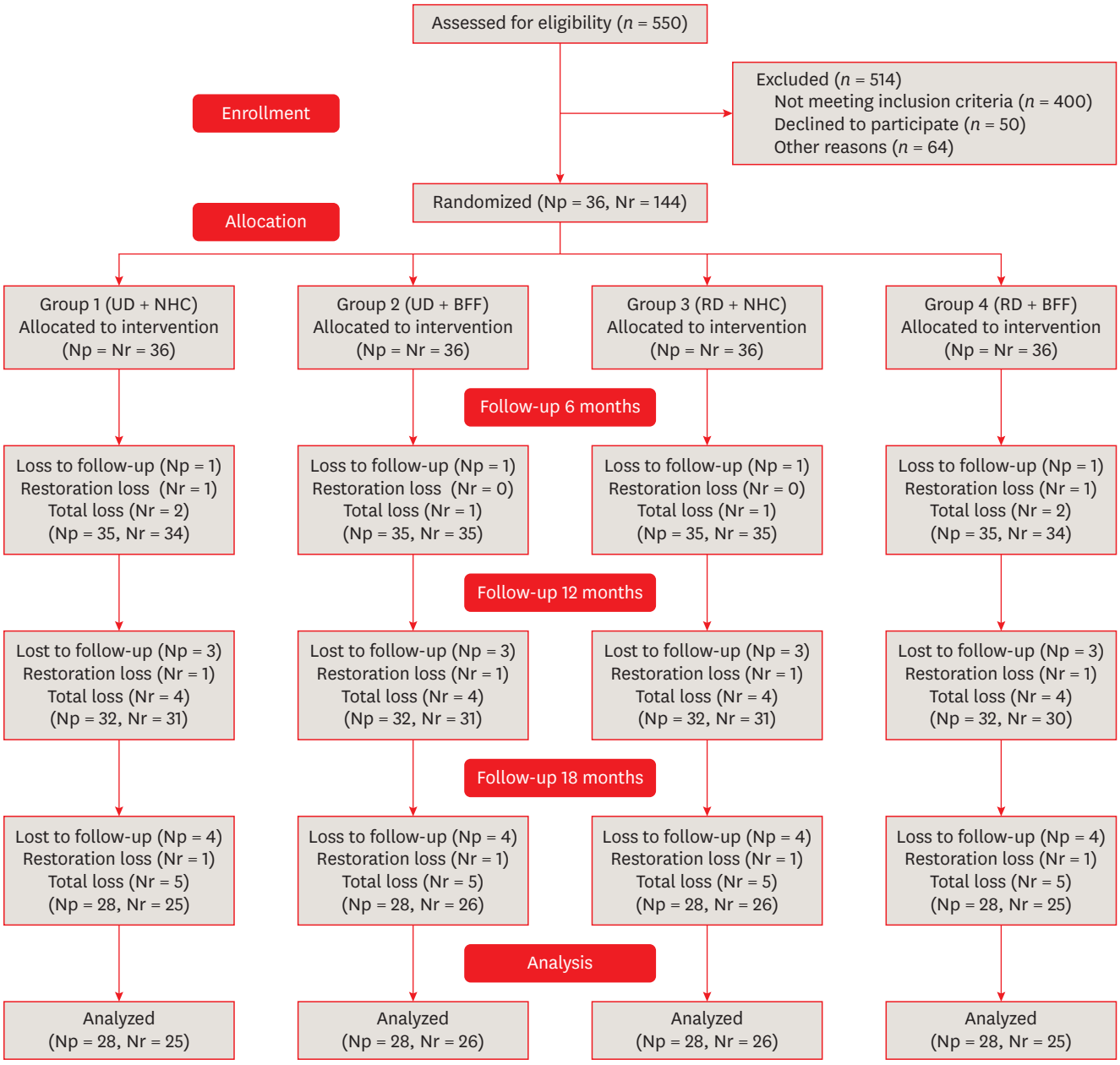

Figure 2. CONSORT study flowchart.
BFF, bulk-fill flowable; NHC, nanohybrid composite; RD, roughened dentin; UD, unroughened dentin; Np, number of patients; Nr, number of restorations.

those of other studies. Therefore, we analyzed the results across groups, focusing on the 2 primary variables: the effect of dentin roughening and the effect of the restorative material.

Effect of restorative material

In group I and group II of this study, dentin roughening was not performed; the only difference between those groups was the restorative material used. Only 2 *in vivo* studies, conducted by Vildósola *et al.* [19] and Canali *et al.* [20], have compared bulk-fill composites and NHCs in the restoration of NCCLs. These researchers found the performance of both BFF composite and NHC to be clinically acceptable, with no significant differences in the examined parameters.

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Table 1. Non-carious cervical lesion (NCCL) characteristics: shape, cervico-incisal size of the lesion, degree of sclerotic dentin, presence of antagonist, presence of preoperative sensitivity, and tooth and arch distribution

NCCL characteristics	Group I (UD+NHC)	Group II (UD+BFF)	Group III (RD+NHC)	Group IV (RD+BFF)
Shape (degree of angle)				
< 45	0	0	0	0
45–90	12	15	16	14
90–135	14	15	14	14
> 135	10	6	6	8
Cervico-incisal height (mm)				
< 1.5	3	6	7	7
1.5–2.5	14	12	14	12
> 2.5	19	18	15	17
Degree of sclerotic dentin				
1	8	10	13	13
2	10	15	15	14
3	12	6	4	3
4	6	5	4	6
Presence of antagonist				
Yes	36	36	36	36
No	0	0	0	0
Preoperative sensitivity (spontaneous)				
Yes	0	0	0	0
No	36	36	36	36
Preoperative sensitivity (air-dry)				
Yes	20	18	22	20
No	16	18	14	16
Tooth distribution				
Anterior				
Incisor	6	7	7	6
Canine	6	10	8	7
Posterior				
Premolar	23	17	20	20
Molar	1	2	1	3
Arc distribution				
Maxillary	28	32	24	24
Mandibular	8	4	12	12

UD, unroughened dentin; NHC, nanohybrid composite; BFF, bulk-fill flowable; RD, roughened dentin.

This finding aligns with the results of our study. However, our results contradict the *in vitro* study by Correia *et al.* [21], which found reduced gap formation with BFF composites. In our study, the criteria related to gap formation, such as marginal staining, marginal adaptation, and caries, did not significantly differ between the 2 groups. This discrepancy in results can be attributed to the different design (*in vitro*), methodology, and assessment technique (stereomicroscope with ×50 magnification) used by Correia *et al.* [21]. Moreover, the cavity margins in the study by Correia *et al.* [21] were located exclusively in enamel.

Kemp-Scholte and Davidson [17], as well as Ichim *et al.* [18], have underscored the importance of a low modulus of elasticity in class V restorations. However, in the present study, no significant difference was observed in any criteria, including retention rate and marginal integrity, between the BFF composite and NHC groups (with or without dentin roughening), despite the differing elastic modulus of the NHC (20.4 GPa) and BFF (6-7 GPa) groups. These findings align with those reported in studies by Peumans *et al.* [25], van Dijken and Pallesen [26], and Kubo *et al.* [27], in which no significant differences were observed in the clinical performance of composite materials with varying stiffness values (moduli of elasticity). One potential factor that could account for the lack of difference in the clinical performance of these materials is the selection criteria used in our study. Although studies

Table 2. Clinical assessment of restorations, expressed as numbers of restorations and corresponding percentages (%)

	Group I				Group II				Group III				Group IV			
Criteria																
S	Baseline	6 months	12 months	18 months	Baseline	6 months	12 months	18 months	Baseline	6 months	12 months	18 months	Baseline	6 months	12 months	18 months
Marginal staining																
1	36 (100.0%)	32 (88.9%)	26 (72.2%)	21 (58.3%)	36 (100.0%)	30 (83.3%)	27 (75%)	22 (61.1%)	36 (100.0%)	32 (88.9%)	27 (75%)	23 (63.9%)	36 (100.0%)	33 (91.7%)	29 (80.6%)	23 (63.9%)
2	0%	2 (5.6%)	4 (11.1%)	2 (5.6%)	0%	4 (11.1%)	4 (11.1%)	2 (5.6%)	0%	3 (8.3%)	4 (11.1%)	3 (8.3%)	0%	1 (2.8%)	1 (2.8%)	2 (5.6%)
3	0%	0%	0%	1 (2.8%)	0%	1 (2.8%)	0%	2 (5.6%)	0%	0%	0%	0%	0%	0%	0%	1 (2.8%)
4	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Missing*		2 (5.6%)	6 (16.7%)	12 (33.3%)		1 (2.8%)	5 (13.9%)	10 (27.8%)		1 (2.8%)	5 (13.9%)	10 (27.8%)		2 (5.6%)	6 (16.7%)	10 (27.8%)
Fracture/retention																
1	36 (100%)	33 (91.7%)	28 (77.8%)	24 (66.7%)	36 (100%)	33 (91.7%)	30 (83.3%)	25 (69.4%)	36 (100%)	33 (91.7%)	30 (83.3%)	26 (72.2%)	36 (100%)	34 (94.4%)	30 (83.3%)	26 (72.2%)
2	0%	1 (2.8%)	1 (2.8%)	0%	0%	1 (2.8%)	1 (2.8%)	1 (2.8%)	0%	1 (2.8%)	1 (2.8%)	0%	0%	0%	0%	0%
3	0%	0%	1 (2.8%)	0%	0%	1 (2.8%)	0%	0%	0%	1 (2.8%)	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5	0%	1 (2.8%)	1 (2.8%)	2 (5.6%)	0%	0%	1 (2.8%)	1 (2.8%)	0%	0%	1 (2.8%)	1 (2.8%)	0%	1 (2.8%)	1 (2.8%)	0%
Missing*		1 (2.8%)	5 (13.9%)	10 (27.8%)		1 (2.8%)	4 (11.1%)	9 (25%)		1 (2.8%)	4 (11.1%)	9 (25%)		1 (2.8%)	5 (13.9%)	10 (27.8%)
Marginal adaptation																
1	36 (100.0%)	32 (88.9%)	27 (75%)	22 (61.1%)	36 (100.0%)	33 (91.7%)	27 (75%)	24 (66.7%)	36 (100.0%)	34 (94.4%)	28 (77.8%)	25 (69.4%)	36 (100.0%)	33 (91.7%)	29 (80.6%)	25 (69.4%)
2	0%	2 (5.6%)	2 (5.6%)	2 (5.6%)	0%	1 (2.8%)	2 (5.6%)	2 (5.6%)	0%	1 (2.8%)	3 (8.3%)	1 (2.8%)	0%	1 (2.8%)	1 (2.8%)	1 (2.8%)
3	0%	0%	0%	0%	0%	1 (2.8%)	1 (2.8%)	0%	0%	0%	0%	0%	0%	0%	0%	0%
4	0%	0%	1 (2.8%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	5	0%	0%	0%	1 (2.85%)	0%	0%	0%	0%	0%	0%	0%	0%
Missing*		2 (5.6%)	6 (16.7%)	12 (33.3%)		1 (2.8%)	6 (16.7%)	9 (25%)		1 (2.8%)	5 (13.9%)	10 (27.8%)		2 (5.6%)	6 (16.7%)	10 (27.8%)
Postoperative sensitivity																
1	36 (100.0%)	34 (94.4%)	30 (83.3%)	25 (69.4%)	36 (100.0%)	35 (97.2%)	30 (83.3%)	26 (72.2%)	36 (100.0%)	35 (97.2%)	31 (86.1%)	26 (72.2%)	36 (100.0%)	34 (94.4%)	30 (83.3%)	26 (72.2%)
2	0%	0%	0%	0%	0%	0%	1 (2.8%)	0%	0%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Missing*		2 (5.6%)	6 (16.7%)	11 (30.6%)		1 (2.8%)	5 (13.9%)	10 (27.8%)		1 (2.8%)	5 (13.9%)	10 (27.8%)		2 (5.6%)	6 (16.7%)	10 (27.8%)
Recurrence of caries																
1	36 (100.0%)	34 (94.4%)	30 (83.3%)	24 (66.7%)	36 (100.0%)	35 (97.2%)	31 (86.1%)	26 (72.2%)	36 (100.0%)	35 (97.2%)	30 (83.3%)	24 (66.7%)	36 (100.0%)	34 (94.4%)	30 (83.3%)	26 (72.2%)
2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1 (2.8%)	2 (5.6%)	0%	0%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Missing*		2 (5.6%)	6 (16.7%)	12 (33.3%)		1 (2.8%)	5 (13.9%)	10 (27.8%)		1 (2.8%)	5 (13.9%)	10 (27.8%)		2 (5.6%)	6 (16.7%)	10 (27.8%)

*Missing due to loss to follow-up or retention loss of the restoration.

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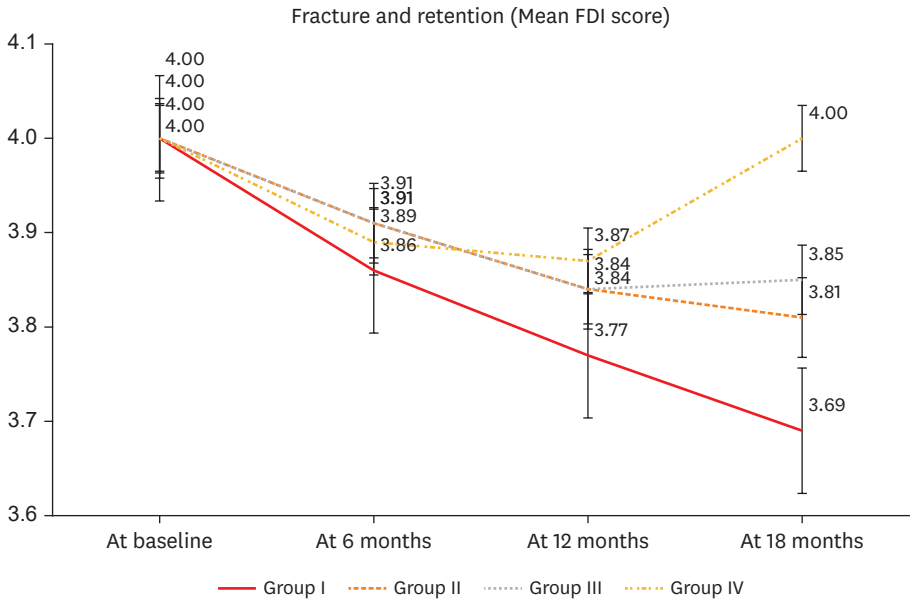

Figure 3. Mean FDI World Dental Federation (FDI) scores for fracture and retention. Retention loss became progressively more common as the follow-up period increased. The groups under study were as follows: group I, nanohybrid composite; group II, bulk-fill composite; group III, roughened dentin and nanohybrid composite; and group IV, roughened dentin and bulk-fill composite.

[28,29] have demonstrated a positive correlation between parafunctional habits and the presence of NCCLs, we excluded patients with parafunctional habits. As a result, a relatively large number of non-abfraction NCCLs were present in our study.

Effect of dentin roughening

Meta-analyses conducted by Heintze *et al.* [3], Rocha *et al.* [10], and Mahn *et al.* [11] have recommended dentin roughening to enhance the durability of restorations. However, in our observations, dentin roughening did not significantly affect the outcome, regardless of whether the restorative material was the same (as in group I versus III and group II versus IV) or different (as in group III versus IV, group I versus IV, and group II versus III). Both Mahn *et al.* [11] and Rocha *et al.* [10] based their conclusions on a variety of heterogeneous studies that employed different assessment criteria, adhesive systems, and techniques. Furthermore, Heintze *et al.* [3] did not analyze studies based on clinical parameters such as dentin/enamel preparation, and some of their included studies even involved class III restorations. In the present study, most of the included cases exhibited mild sclerosis (grade 1 or 2). Therefore, the roughening of dentin may not have produced the anticipated results.

Interestingly, even the significantly greater number of cases of sclerotic dentin (grade 3) in group I did not appear to influence the results. These findings are consistent with the studies conducted by van Dijken [7,8], which indicated no significant effect of dentin roughening. This lack of effect could be attributed to the fact that dentin roughening removes only the superficial layers of hyper-mineralized dentin, leaving the deeper layers untouched. Furthermore, dentin roughening may produce a smear layer that could potentially jeopardize the formation of the hybrid layer, as it is resistant to acid dissolution [30]. Other potential obstacles to bonding in NCCLs, such as a partially mineralized surface bacterial layer and intra-tubular mineral casts, are unaffected by dentin roughening [31-33].

Role of universal adhesive

The use of universal adhesive may also have influenced the outcomes of the present study. Loguercio *et al.* [6] recently concluded that restorations implemented with universal adhesive demonstrated comparable clinical performance, irrespective of the preparation of the dental substrate of NCCLs. Apparently, newer single-component dentin adhesive systems, including universal adhesives, have enhanced the bond strength to dentin to a degree sufficient to counterbalance other factors, such as dentin modification or differences in the elastic moduli of composite materials. Numerous studies employing single-component systems or universal adhesives have reported negligible or no retention loss [25-27,34-36].

We utilized a universal adhesive in self-etch mode with the aim of reducing the number of clinical steps involved in restoration, thereby decreasing the likelihood of clinical errors. Research has indicated that self-etch mode is superior to total etch [37] or comparable to selective etch in terms of clinical performance [38]; other findings have indicated no significant effect of bonding strategy [39]. Notably, however, conflicting results are present in the literature. For instance, de Paris Matos *et al.* [40] found that the etch-and-rinse strategy was superior to the self-etch strategy.

Fracture and retention

The most important parameter for assessing NCCL restorations is the retention rate, since if the restorations are lost, no other variables can be evaluated [6]. In our study, no statistically significant difference was observed across all groups in fracture and retention at the 18-month mark. The loss of retention can be attributed to a variety of factors, including polymerization shrinkage, thermal changes, oral hygiene, patient age, the restorative material used, the location of the restoration, and occlusal forces [33]. Furthermore, the bonding agent and restorative materials may undergo hydrolytic degradation. In our study, the total loss of retention was 7% (10 of 144 restorations) over an 18-month period. This is higher than the rates reported by the studies of Vildósola *et al.* [19] and Canali *et al.* [20], which were 0% and 2.3%, respectively. The longer follow-up period in our study could explain the higher retention loss observed. While the studies by Vildósola *et al.* [19] and Canali *et al.* [20] had follow-up periods of 6 and 12 months respectively, our study had a follow-up period of 18 months. Various studies have demonstrated that retention loss increases when restorations are evaluated over longer follow-up periods [11,38]. Another potential reason for the higher failure rate in the present study could be the technical aspects related to bonding and the operator's experience, as our study was conducted by a postgraduate student.

In the present study, we employed the FDI criteria for evaluation, as in other comparable studies [6,19]. While many previous studies, and even some contemporary ones, continue to use the United States Public Health Service (USPHS) or modified USPHS criteria, the FDI criteria offer a broader categorization with a greater number of evaluated parameters. This makes these standards more sensitive in detecting potential differences in the various clinical characteristics of a restoration [8,20,21,25,40].

In the present study, an 18-month follow-up period was utilized. The follow-up duration in comparable studies has typically been shorter, ranging from 6 months to 1 year [19,20]. However, our follow-up period could have been extended further, as composite restorations are anticipated to last for a longer period (years) within the oral cavity, and signs of deterioration may take time to manifest. Due to the constraints of the postgraduate period, however, the follow-up period was limited to 18 months in this study.

To maintain uniformity in clinical and other conditions across patients in the study, a modified split-mouth design was employed. This design required at least 4 restorations (1 from each group) to be performed for each patient. This approach helped to ensure that patient-related factors such as occlusal forces, salivary flow, and oral hygiene remained consistent across restorations. Consequently, the likelihood of patient and oral environment-related factors influencing the study outcome was reduced. Furthermore, any loss to follow-up did not result in unbalanced data, as 1 restoration was then omitted from each group. Notably, however, even a single loss to follow-up led to the loss of 4 restorations, thereby diminishing the statistical power.

This study was limited by a small sample size, primarily due to the challenge of locating patients with at least 4 NCCLs. One week prior to the procedure, and again immediately before its commencement, the teeth were cleaned with a pumice slurry. This was done to remove plaque and cleanse the tooth, a practice consistent with other studies [3,7]. The possibility of some degree of dentin roughening during this procedure cannot be entirely discounted. Additionally, most cases included in the study exhibited mild sclerosis. Patients with severe bruxism and parafunctional habits were not included, resulting in a predominance of non-abfraction cases. The attrition rate (loss to follow-up) in this study was high, a circumstance that was unavoidable due to the lockdown conditions imposed by the 2019 coronavirus disease pandemic.

Future clinical studies that incorporate larger sample sizes, extended follow-up periods, and the use of varied adhesive systems are necessary to derive meaningful clinical conclusions. It may be intriguing to conduct a specific study on sclerotic NCCLs or abfraction lesions.

CONCLUSIONS

Within the limitations of this study, no significant difference was observed in the clinical performance of BFF composite and NHC restorations of non-carious cervical lesions over an 18-month follow-up period. This held true irrespective of whether dentin roughening was performed.

REFERENCES

1. Medeiros TL, Mutran SC, Espinosa DG, do Carmo Freitas Faial K, Pinheiro HH, D'Almeida Couto RS. Prevalence and risk indicators of non-carious cervical lesions in male footballers. BMC Oral Health 2020;20:215.
PUBMED | CROSSREF
2. Teixeira DN, Thomas RZ, Soares PV, Cune MS, Gresnigt MM, Slot DE. Prevalence of noncarious cervical lesions among adults: a systematic review. J Dent 2020;95:103285.
PUBMED | CROSSREF
3. Heintze SD, Ruffieux C, Rousson V. Clinical performance of cervical restorations--a meta-analysis. Dent Mater 2010;26:993-1000.
PUBMED | CROSSREF
4. Szesz A, Parreiras S, Martini E, Reis A, Loguercio A. Effect of flowable composites on the clinical performance of non-carious cervical lesions: a systematic review and meta-analysis. J Dent 2017;65:11-21.
PUBMED | CROSSREF
5. Karan K, Yao X, Xu C, Wang Y. Chemical profile of the dentin substrate in non-carious cervical lesions. Dent Mater 2009;25:1205-1212.
PUBMED | CROSSREF

6. Loguercio AD, Luque-Martinez IV, Fuentes S, Reis A, Muñoz MA. Effect of dentin roughness on the adhesive performance in non-carious cervical lesions: a double-blind randomized clinical trial. J Dent 2018;69:60-69.
PUBMED | CROSSREF
7. van Dijken JW. Clinical evaluation of three adhesive systems in class V non-carious lesions. Dent Mater 2000;16:285-291.
PUBMED | CROSSREF
8. van Dijken JW. Retention of a resin-modified glass ionomer adhesive in non-carious cervical lesions. A 6-year follow-up. J Dent 2005;33:541-547.
PUBMED | CROSSREF
9. Lührs AK, Jacker-Guhr S, Günay H, Herrmann P. Composite restorations placed in non-carious cervical lesions-which cavity preparation is clinically reliable? Clin Exp Dent Res 2020;6:558-567.
PUBMED | CROSSREF
10. Rocha AC, Da Rosa W, Cocco AR, Da Silva AF, Piva E, Lund RG. Influence of surface treatment on composite adhesion in non-carious cervical lesions: systematic review and meta-analysis. Oper Dent 2018;43:508-519.
PUBMED | CROSSREF
11. Mahn E, Rousson V, Heintze S. Meta-analysis of the influence of bonding parameters on the clinical outcome of tooth-colored cervical restorations. J Adhes Dent 2015;17:391-403.
PUBMED | CROSSREF
12. van Dijken JW. A prospective 8-year evaluation of a mild two-step self-etching adhesive and a heavily filled two-step etch-and-rinse system in non-carious cervical lesions. Dent Mater 2010;26:940-946.
PUBMED | CROSSREF
13. Loguercio AD, Raffo J, Bassani F, Balestrini H, Santo D, do Amaral RC, *et al.* 24-Month clinical evaluation in non-carious cervical lesions of a two-step etch-and-rinse adhesive applied using a rubbing motion. Clin Oral Investig 2011;15:589-596.
PUBMED | CROSSREF
14. Luque-Martinez I, Muñoz MA, Mena-Serrano A, Hass V, Reis A, Loguercio AD. Effect of EDTA conditioning on cervical restorations bonded with a self-etch adhesive: a randomized double-blind clinical trial. J Dent 2015;43:1175-1183.
PUBMED | CROSSREF
15. Zander-Grande C, Amaral RC, Loguercio AD, Barroso LP, Reis A. Clinical performance of one-step self-etch adhesives applied actively in cervical lesions: 24-month clinical trial. Oper Dent 2014;39:228-238.
PUBMED | CROSSREF
16. Luque-Martinez IV, Mena-Serrano A, Muñoz MA, Hass V, Reis A, Loguercio AD. Effect of bur roughness on bond to sclerotic dentin with self-etch adhesive systems. Oper Dent 2013;38:39-47.
PUBMED | CROSSREF
17. Kemp-Scholte CM, Davidson CL. Complete marginal seal of class V resin composite restorations effected by increased flexibility. J Dent Res 1990;69:1240-1243.
PUBMED | CROSSREF
18. Ichim IP, Schmidlin PR, Li Q, Kieser JA, Swain MV. Restoration of non-carious cervical lesions Part II. Restorative material selection to minimise fracture. Dent Mater 2007;23:1562-1569.
PUBMED | CROSSREF
19. Vildósola P, Nakouzi J, Rodriguez S, Reyes A, Reyes J, Conejeros C. Six-month follow-up of two Bulk-fill composites in non-carious cervical lesions: double blind randomized clinical trial. J Oral Res 2019;8:210-219.
CROSSREF
20. Canali GD, Ignácio SA, Rached RN, Souza EM. One-year clinical evaluation of bulk-fill flowable vs. regular nanofilled composite in non-carious cervical lesions. Clin Oral Investig 2019;23:889-897.
PUBMED | CROSSREF
21. Correia A, Jurema A, Andrade MR, Borges A, Bresciani E, Caneppele T. Clinical evaluation of noncarious cervical lesions of different extensions restored with bulk-fill or conventional resin composite: preliminary results of a randomized clinical trial. Oper Dent 2020;45:E11-E20.
PUBMED | CROSSREF
22. Aw TC, Lepe X, Johnson GH, Mancl L. Characteristics of noncarious cervical lesions: a clinical investigation. J Am Dent Assoc 2002;133:725-733.
PUBMED | CROSSREF
23. Swift EJ Jr, Perdigão J, Heymann HO, Wilder AD Jr, Bayne SC, May KN Jr, *et al.* Eighteen-month clinical evaluation of a filled and unfilled dentin adhesive. J Dent 2001;29:1-6.
PUBMED | CROSSREF

24. Hickel R, Peschke A, Tyas M, Mjör I, Bayne S, Peters M, *et al.* FDI World Dental Federation: clinical criteria for the evaluation of direct and indirect restorations-update and clinical examples. Clin Oral Investig 2010;14:349-366.
PUBMED | CROSSREF

25. Peumans M, De Munck J, Van Landuyt KL, Kanumilli P, Yoshida Y, Inoue S, *et al.* Restoring cervical lesions with flexible composites. Dent Mater 2007;23:749-754.
PUBMED | CROSSREF

26. van Dijken JW, Pallesen U. A 7-year randomized prospective study of a one-step self-etching adhesive in non-carious cervical lesions. The effect of curing modes and restorative material. J Dent 2012;40:1060-1067.
PUBMED | CROSSREF

27. Kubo S, Yokota H, Yokota H, Hayashi Y. Three-year clinical evaluation of a flowable and a hybrid resin composite in non-carious cervical lesions. J Dent 2010;38:191-200.
PUBMED | CROSSREF

28. Femiano F, Femiano R, Femiano L, Festa V, Rullo R, Perillo L. Noncarious cervical lesions: correlation between abfraction and wear facets in permanent dentition. Open J Stomatol 2015;5:152-157.
CROSSREF

29. Takehara J, Takano T, Akhter R, Morita M. Correlations of noncarious cervical lesions and occlusal factors determined by using pressure-detecting sheet. J Dent 2008;36:774-779.
PUBMED | CROSSREF

30. Kwong SM, Cheung GS, Kei LH, Itthagarun A, Smales RJ, Tay FR, *et al.* Micro-tensile bond strengths to sclerotic dentin using a self-etching and a total-etching technique. Dent Mater 2002;18:359-369.
PUBMED | CROSSREF

31. Tay FR, Pashley DH. Resin bonding to cervical sclerotic dentin: a review. J Dent 2004;32:173-196.
PUBMED | CROSSREF

32. Tay FR, Kwong SM, Itthagarun A, King NM, Yip HK, Moulding KM, *et al.* Bonding of a self-etching primer to non-carious cervical sclerotic dentin: interfacial ultrastructure and microtensile bond strength evaluation. J Adhes Dent 2000;2:9-28.
PUBMED

33. Van Meerbeek B, Braem M, Lambrechts P, Vanherle G. Morphological characterization of the interface between resin and sclerotic dentine. J Dent 1994;22:141-146.
PUBMED | CROSSREF

34. Ritter AV, Heymann HO, Swift EJ Jr, Sturdevant JR, Wilder AD Jr. Clinical evaluation of an all-in-one adhesive in non-carious cervical lesions with different degrees of dentin sclerosis. Oper Dent 2008;33:370-378.
PUBMED | CROSSREF

35. Ruschel VC, Shibata S, Stolf SC, Chung Y, Baratieri LN, Heymann HO, *et al.* Eighteen-month clinical study of universal adhesives in noncarious cervical lesions. Oper Dent 2018;43:241-249.
PUBMED | CROSSREF

36. Zanatta RF, Silva TM, Esper M, Bresciani E, Gonçalves S, Caneppele T. Bonding performance of simplified adhesive systems in non carious cervical lesions at 2-year follow-up: a double-blind randomized clinical trial. Oper Dent 2019;44:476-487.
PUBMED | CROSSREF

37. Cruz J, Silva AL, Eira R, Coito C, Sousa BR, Lopes MM, *et al.* 24-month clinical performance of a universal adhesive on non-carious cervical lesions: self-etch and etch-and-rinse techniques. J Adhes Dent 2021;23:379-387.
PUBMED | CROSSREF

38. Rouse MA, May JT, Platt JA, Cook NB, Capin OR, Adams BN, *et al.* Clinical evaluation of a universal adhesive in non-carious cervical lesions. J Esthet Restor Dent 2020;32:691-698.
PUBMED | CROSSREF

39. Lawson NC, Robles A, Fu CC, Lin CP, Sawlani K, Burgess JO. Two-year clinical trial of a universal adhesive in total-etch and self-etch mode in non-carious cervical lesions. J Dent 2015;43:1229-1234.
PUBMED | CROSSREF

40. de Paris Matos T, Perdigão J, de Paula E, Coppla F, Hass V, Scheffer RF, *et al.* Five-year clinical evaluation of a universal adhesive: a randomized double-blind trial. Dent Mater 2020;36:1474-1485.
PUBMED | CROSSREF