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Clinical Research

Two-year Clinical Effectiveness of Adhesives and Retention Form on Resin Composite Restorations of Non-carious Cervical Lesions

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Clinical Relevance

Over a two–year observation period, ScotchBond Multi-Purpose was found to have significantly superior marginal adaptation compared to Adper Prompt. Restorations using retention forms showed a significantly higher retention rate in an experimental adhesive and significantly less marginal discoloration in all three adhesives.

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SUMMARY

The current study investigated the clinical effectiveness of three adhesives and the use of retention form in Class V resin composite restorations of the non-carious cervical lesion (NCCL) over a two-year period. One-hundred and fifty NCCLs in 39 patients were restored with resin composites according to six experimental protocols combining the presence or absence of retention form and three adhesives: ScotchBond Multi-Purpose (MP, 3M ESPE), an experimental adhesive (EX, Vericom) and Adper Prompt (AP, 3M ESPE). All

restorations were evaluated at baseline, 6, 12 and 24 months. Modified United States Public Health Service (USPHS) criteria were used to evaluate the restorations. MP was found to have significantly superior marginal adaptation than AP in cumulative logistic regression analysis (odds ratio, 2.12; 95% confidence interval, 1.05-4.31; *p*=0.0397). In analysis using the Pearson's Chi-square or Fisher's Exact Test to compare the clinical performance of restorations with and without retention form, EX with retention form showed a significantly higher retention rate at two years than that without retention form (*p*=0.0089). Restorations with retention form also showed significantly less marginal discoloration than those without retention form in all three adhesives (*p*=0.0336).

INTRODUCTION

The non-carious cervical lesion (NCCL) is a common finding in the oral cavity and has been reported in up to 85% of dental patients.[1] The main etiologies of NCCL are suggested to be abrasion, erosion and abfraction caused by tooth flexure, while the pathogenesis of NCCL appears to be a multi-factorial effect of these factors.[2] Treatment for NCCL may include various restorations, occlusal adjustment and oral hygiene instruction.[3] Indications for restoring NCCL include protection against further loss of tooth structure, hypersensitivity, esthetics and the need to use the affected tooth for abutment of a removable partial denture.[3-4] Restorations of the NCCL are generally performed with tooth-colored materials, such as resin composites, glass-ionomer cement and compomer. Of these materials, resin composites are used most often, because of their excellent esthetic and physical properties.

Resin composite restorations in the oral cavity may have a long-term durability problem due to residual stress resulting from polymerization shrinkage. In addition, long-term durability may be affected by external factors, such as multi-directional loading by mastication, thermal stress by alternating cold and hot stimuli and wear from tooth brushing.[5-9] In particular, repetitive compressive and tensile stresses caused by tooth flexure in cervical lesions can contribute to dislodging of the restorations.[10-11] Also, the surface of NCCLs typically consist of sclerotic dentin, which is resistant to acid etching. This can prevent maximum adhesion.[12]

In spite of the unfavorable nature of the NCCL, the Class V resin composite restorations of the NCCL have shown a high clinical retention rate after the advent of three-step etch&rinse adhesives.[13-15] Recently, various user-friendly adhesive systems, such as two-step etch&rinse, two-step self-etch and one-step self-etch adhesives, have been developed to overcome technique sensitivity of the multi-step procedure; however, these simplified systems have shown inferior *in vitro* test results and inconsistent clinical performances when compared to three-step etch&rinse adhesives.[16-18] Studies on the clinical performance of various adhesives have been reported; however, there are few studies that simultaneously compare the clinical performance of different adhesive types.

While there is a trend toward preparing no macromechanical retention form in Class V resin composite restorations,[4,19] placement of a retention groove in the NCCL has been suggested to have advantages, including enhancing retention and increasing resistance to marginal leakage.[20-21] Disadvantages of a retention groove include loss of tooth structure and possible pulp damage. While most clinical studies on resin composite restorations of the NCCL have reported on the clinical performance of adhesive systems over time without retention form, clinical studies on the effectiveness of retention form are few.

The current study evaluated the clinical effectiveness of adhesives and retention form applied to NCCL Class V resin composite restorations. In the current two-year clinical assessment of the NCCL Class V resin composite restorations, two null hypotheses were established. First, there were no differences among adhesives and, second, there were no differences between restoration groups with and without retention form. To test these hypotheses, NCCL Class V resin composite restorations were performed using three different adhesives on cavities with or without retention form. The clinical performance of the restorations at baseline, 6, 12 and 24 months was evaluated using modified United States Public Health Service (USPHS) criteria.[22]

METHODS AND MATERIALS

Thirty-nine patients with at least two premolar NCCLs who visited Seoul National University Dental Hospital (SNUDH) between January 1 and June 30, 2005, participated in this study. Their mean age was 50 years, while they ranged from 34 to 65 years. The participants were apparently healthy patients with good oral hygiene. Patients who had severe periodontitis, rampant caries, xerostomia, orthodontic appliances or were pregnant or nursing were excluded. The Internal Review Board of SNUDH approved the clinical trial protocol. Each patient was informed of the study and signed a consent form.

Six experimental groups combining three adhesives and the presence or absence of retention form were compared in this study. The adhesives used were ScotchBond Multi-Purpose (MP, 3M ESPE, St Paul, MN, USA), an experimental adhesive (EX, Vericom, Anyang, Korea) and Adper Prompt (AP, 3M ESPE, Seefeld, Germany). All NCCLs were restored with

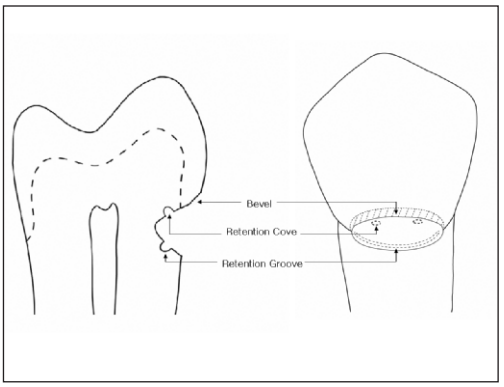

Figure 1. *Cavity preparation for a Class V resin composite restoration of non-carious cervical lesion. After removing sclerotic dentin in the groups with retention form, cervical retention groove and incisal retention coves were prepared at 0.5 mm from the cervical margin and the dentino-enamel junction, respectively. Finally, a bevel 0.5 mm wide was prepared at the incisal enamel margin. In the groups without retention form, after removing sclerotic dentin, only the bevel was prepared.*

light-cured hybrid resin composites (Denfil, Vericom, Anyang, Korea). One-hundred and fifty NCCLs from 39 patients were randomly assigned to the six experimental groups, resulting in 25 NCCLs per group. To minimize patient-related effects that may bias the results, the authors of this study allowed no more than three restorations of one group in a patient.

After color matching with a Vita shade guide (Vita-Zahnfabrik, Bad Säckingen, Germany), the shiny sclerotic surface of all NCCLs was lightly removed with a #2 low-speed round bur (Komet, Lemgo, Germany). In the group with retention form, gingival retention groove and incisal retention coves were prepared with a #1/4 low-speed round bur (Komet, Germany) at 0.5 mm from the gingival margin and the dentino-enamel junction, respectively (Figure 1). The incisal enamel margin was beveled by 0.5 mm with a fine diamond bur (Mani, Tochigi, Japan). The prepared cavity was cleansed with plain pumice slurry in a rubber cup. The cavity was isolated with a cotton roll and gingival retraction cord. If needed to prevent patient discomfort during restorative procedures, local anesthesia was applied.

Bonding procedures of the adhesives were performed as shown in Table 1. Resin composites were filled in two or three increments and each increment was light-cured for 40 seconds with an LED light-curing unit (Elipar Freelight 2, 3M ESPE). The intensity of curing light was measured by a portable radiometer (Model 100, Demetron Research Corporation, Danbury, CT, USA) prior to each restoration procedure to confirm the values >600 mW/cm^2. Finishing and polishing were

Table 1: *Adhesive Systems Used in This Study*

Adhesive	Classification	Components	Bonding Procedures
ScotchBond Multipurpose (MP)	Three-step etch&rinse	Primer: HEMA, polyalkenoic acid copolymer, water Adhesive: bis-GMA, HEMA, CQ, amine	- 36% phosphoric acid: total etch start from the enamel margin and, at the end, inject the etchant onto the dentin surface within the cavity, wait for 15 seconds - rinse for 15 seconds - blot dry with a cotton pellet - apply primer - gently air dry - apply adhesive - light cure for 10 seconds
Experimental adhesive (EX)	Two-step etch&rinse	HEMA, Bis-GMA, 4-(Merhacryloyloxyethyl)-trimellitic acid anhydride, ethyl amino benzoate, CQ, ethanol	- 36% phosphoric acid: total etch start from the enamel margin and, at the end, inject the etchant onto the dentin surface within the cavity, wait for 15 seconds - rinse for 15 seconds - blot dry with a cotton pellet - apply two coats of self-priming adhesive - wait for 10 seconds - gently air dry - light cure for 10 seconds
Adper Prompt (AP)	One-step self-etch	Liquid A: methacrylated phosphoric ester, bis-GMA, initiators based on CQ, stabilizer Liquid B: water, HEMA, polyalkenoic acid, stabilizer	- rinse and air dry - mix liquid A & B in a well - apply self-etching adhesive with agitation for 15 seconds - wait for 20 seconds - apply a second coat of adhesive with agitation for 15 seconds - wait for 20 seconds - gently air dry - light cure for 10 seconds

Table 2: *Modified US Public Health Service (USPHS) Criteria Used in This Study*

Category	Scale	Criteria
Retention	Alpha	present
	Bravo	partial loss
	Charlie	absent
Color match	Alpha	no mismatch to the adjacent tooth structure
	Bravo	slight mismatch but clinically acceptable
	Charlie	esthetically unacceptable mismatch
Marginal discoloration	Alpha	no discoloration on the margin
	Bravo	superficial discoloration on the margin
	Charlie	deep discoloration penetrated in a pulpal direction
Secondary caries	Alpha	no caries present
	Charlie	caries present
Wear (anatomic form)	Alpha	anatomy resembles original restoration
	Bravo	anatomy shows change in contour but not requiring replacement
	Charlie	excessive wear with dentin exposure requiring replacement
Marginal adaptation	Alpha	continuity at the margin (no ledge or ditch)
	Bravo	slight discontinuity detectable with an explorer but not requiring replacement
	Charlie	marginal ledge or crevice requiring replacement
Postoperative sensitivity	Alpha	absent
	Charlie	present

accomplished using an extra fine diamond point (Mani, Tochigi, Japan) and Sof-Lex discs (3M ESPE). One experienced operator, familiar with adhesive dentistry, performed all the restorations.

The restorations were examined blindly at baseline, 6, 12 and 24 months by two independent observers, not the operator. A modified USPHS scale was used to evaluate the clinical performance of the restorations (Table 2).[22] Retention, marginal discoloration, marginal adaptation, color match and wear were measured on a three-ordered scale: Alpha, Bravo and Charlie, with Charlie being the poorest. Secondary caries and postoperative sensitivity were measured using a dichotomous scale: Alpha and Charlie. If a discrepancy between observers occurred, it was resolved by consensus. Missing cases, including unannounced nonattendance of subject at recall, were withdrawn from the study. A restoration with a retention score of Charlie was counted as missing in the other evaluation categories.

The retention rate at 24 months after placement was analyzed by two-level logistic regression, while marginal discoloration and marginal adaptation at 6, 12 and 24 months, with three-point ordered outcomes, were modeled by two-level cumulative logistic regression, with the first level being tooth or cavity related and the second level being patient related. Multiple measurements from one patient used the generalized linear model for correlated outcomes.[23] Multi-level models for responses of marginal discoloration and marginal adaptation, considering both repeated times and multiple measurements from one patient, were constructed as three-level cumulative logistic regression models for showing poor clinical outcomes from Alpha to Bravo or Charlie and from Alpha or Bravo to Charlie. Main effect models were constructed for all models in this analysis, because interaction terms appeared statistically insignificant. Some responses for color match, wear, postoperative sensitivity and retention could not be modeled because of a lack of variation. Comparisons of clinical performance of restorations with and without retention form were also assessed using the Pearson's Chi-square Test or Fisher's Exact Test, as appropriate.[24] A level of 0.05 was adapted to determine the statistical significance of differences. All analyses were performed by SAS statistical software, version 9.1.3 (SAS Institute, Cary, NC, USA), and most models were calculated using the GLIMMIX procedure.[25]

RESULTS

Of the 150 restorations at baseline, 149 (99.3%), 143 (95.3%) and 122 (81.3%) were observed at 6, 12 and 24 months, respectively. Descriptive data expressed as percentages of outcomes for the six groups are shown in Table 3. While MP and AP showed high retention rates of 94% to 100% irrespective of retention form during the follow-up at two years, EX without retention form showed a significantly decreased retention rate of 71.4% at two years, as compared to that with retention form, which showed 100% retention (p=0.0089; Fisher's Exact Test). Regarding marginal discoloration, Alpha scores decreased in most groups from baseline to two years. Restorations with retention form showed significantly less marginal discoloration compared to those without retention form in all three adhesives (p=0.0336; Pearson's Chi-square Test). As for marginal adaptation, Alpha scores decreased in all groups from baseline to two years; however, no significant differences were found between groups with and without

retention form. Other categories of clinical performance, including color match, anatomic form, postoperative sensitivity and secondary caries, did not show statistically significant changes over time in all groups. Only two restorations, one each in MP and AP without retention form, showed postoperative sensitivity at baseline; however, they did not show sensitivity in the following assessments.

The results of multi-level cumulative logistic regression analysis for retention, marginal discoloration and marginal adaptation, which showed worsening outcomes over time, are presented in Tables 4 and 5. AP showed significantly inferior marginal adaptation than MP in three-level cumulative logistic regression analysis (odds ratio, 2.12; 95% confidence interval, 1.05-4.31; p=0.0397).

Table 3: *Percentages of Clinical Outcomes in Each Criterion*

	MP						EX						AP					
	Without RF			With RF			Without RF			With RF			Without RF			With RF		
Criterion	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Retention																		
baseline	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
6 month	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
1 year	100	0	0	95.8	0	4.2	95.6	0	4.4	100	0	0	100	0	0	100	0	0
2 year *	100	0	0	94.4	0	5.6	71.4*	0	28.6	100*	0	0	100	0	0	100	0	0
Color match																		
baseline	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
6 month	100	0	0	100	0	0	96	4	0	100	0	0	100	0	0	100	0	0
1 year	100	0	0	100	0	0	95.5	4.5	0	100	0	0	100	0	0	100	0	0
2 year	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
Marginal discoloration																		
baseline	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
6 month	96	4	0	96	4	0	88	12	0	96	4	0	87.5	12.5	0	96	4	0
1 year	87.5	12.5	0	86.9	13.1	0	81.8	18.2	0	83.3	16.7	0	78.2	21.8	0	96	4	0
2 year #	83.3	16.7	0	94.1	5.9	0	73.3	26.7	0	81.8	18.2	0	63.6	36.4	0	90.5	9.5	0
Wear (anatomic form)																		
baseline	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
6 month	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
1 year	100	0	0	95.7	4.3	0	100	0	0	100	0	0	100	0	0	100	0	0
2 year	94.4	5.6	0	94.1	5.9	0	100	0	0	90.9	9.1	0	100	0	0	95.2	0	4.8
Marginal adaptation																		
baseline	96	4	0	96	4	0	96	4	0	96	4	0	96	4	0	96	4	0
6 month	92	8	0	96	4	0	96	4	0	92	8	0	83.3	16.7	0	88	12	0
1 year	91.7	8.3	0	87	13	0	90.9	9.1	0	83.3	16.7	0	78.3	21.7	0	84	16	0
2 year	72.2	27.8	0	82.4	17.6	0	80	20	0	63.6	36.4	0	63.6	36.4	0	71.4	23.8	4.8
Postoperative sensitivity																		
baseline	96		4	100		0	100		0	100		0	96		4	100		0
6 month	100		0	100		0	100		0	100		0	100		0	100		0
1 year	100		0	100		0	100		0	100		0	100		0	100		0
2 year	100		0	100		0	100		0	100		0	100		0	100		0
Secondary caries																		
baseline	100		0	100		0	100		0	100		0	100		0	100		0
6 month	100		0	100		0	100		0	100		0	100		0	100		0
1 year	100		0	100		0	100		0	100		0	100		0	100		0
2 year	100		0	100		0	100		0	100		0	100		0	100		0
Recall rate																		
baseline	100 (25/25)			100 (25/25)			100 (25/25)			100 (25/25)			100 (25/25)			100 (25/25)		
6 month	100 (25/25)			100 (25/25)			100 (25/25)			100 (25/25)			96 (24/25)			100 (25/25)		
1 year	96 (24/25)			96 (24/25)			92 (23/25)			96 (24/25)			92 (23/25)			100 (25/25)		
2 year	72(18/25)			72(18/25)			84(21/25)			88(22/25)			88(22/25)			84 (21/25)		

Abbreviations: RF, retention form; MP, ScotchBond Multi-Purpose; EX, experimental adhesive and AP, Adper Prompt
**Retention rate of EX with retention form at two years was significantly higher than that without retention form (p=0.0089, Fisher's Exact Test).*
#At two years, the restorations with retention form showed significantly less marginal discoloration than those without retention form in all adhesive groups (p=0.0336, Pearson's Chi-square Test).

Table 4: *Results of two-level (cumulative) logistic regressions using a generalized linear model for having worse clinical outcomes (Alpha→Bravo→Charlie) at two years compared to the baseline with references to adhesive MP and to having no retention form and considering correlated outcomes from the same person.*

Clinical Performance Indicator	Variables		Odds Ratio (95% Confidence Interval)	*p*-value
Retention	Adhesives	AP	0.96 (0.05-18.90)	0.9791
		EX	6.36 (0.62-65.52)	0.1248
		MP	reference	-
	Retention form	presence	0.30 (0.05-1.83)	0.1995
		absence	reference	-
Marginal discoloration	Adhesives	AP	2.41 (0.65-8.96)	0.1926
		EX	2.51 (0.64-9.89)	0.1930
		MP	reference	-
	Retention form	presence	0.36 (0.13-1.01)	0.0576
		absence	reference	-
Marginal adaptation	Adhesives	AP	1.66 (0.60-4.61)	0.3250
		EX	1.42 (0.49-4.10)	0.5256
		MP	reference	-
	Retention form	presence	0.98 (0.43-2.23)	0.9684
		absence	reference	-

Table 5: *Results of three-level cumulative logistic regressions using a generalized linear model for having worse clinical outcomes (Alpha→Bravo→Charlie) considering correlated outcomes from the hierarchical structure of person, teeth and time (baseline, 6-, 12- and 24-months).*

Clinical Performance Indicator	Variables		Odds Ratio (95% Confidence Interval)	*p*-value
Marginal discoloration	Adhesives	AP	1.65 (0.52-5.24)	0.3946
		EX	1.95 (0.60-6.33)	0.2690
		MP	reference	-
	Retention form	presence	0.54 (0.21-1.44)	0.2035
		absence	reference	-
Marginal adaptation	Adhesives	AP	2.12 (1.05-4.31)	0.0397*
		EX	1.18 (0.53-2.64)	0.6763
		MP	reference	-
	Retention form	presence	0.90 (0.49-1.65)	0.7370
		absence	reference	-

**Marginal adaptation of AP was significantly inferior to that of MP over a two-year period.*

DISCUSSION

In the current study, a prospective randomized controlled clinical trial was performed on the clinical effectiveness of adhesives and retention form in the resin composite restorations of NCCL. Regarding the clinical effectiveness of adhesives over two years, AP showed a significantly inferior marginal adaptation than MP (three-level cumulative logistic regression analysis, p=0.0397). Regarding the clinical effectiveness of retention form, restorations with retention form showed a significantly better retention rate than those without retention form in only EX at two years (p=0.0089, Fisher's Exact Test). There was not a significant difference in the retention rate of MP or AP. Restorations with retention form showed significantly less marginal discoloration than those without retention form in all three adhesives (p=0.0336, Pearson's Chi-square Test). Therefore, the two null hypotheses on the clinical effectiveness of adhesives and retention form were denied in the current study.

Previous studies have concluded that three-step etch&rinse adhesives had a superior clinical performance over simplified adhesives that have shown inconsistent clinical performances.[16,26-28] In the current study, without retention form, EX of the two-step etch&rinse type showed a marked decreased retention rate (71.4%) at two years, suggesting its long-term durability may be poor. The guidelines for dentin and enamel adhesive

materials advanced by the American Dental Association (ADA) suggest that, without specific retention features, the retention rate at six months must be at least 95% to acquire provisional acceptance, whereas the retention rate at 18 months must be at least 90% for full acceptance.[19] While EX fulfilled the provisional acceptance criterion, it could not fulfill the full acceptance criterion without retention form. Peumans and others, in their systemic review of clinical trials, reported that, while 79% of the two-step etch&rinse adhesives fulfilled the provisional acceptance of the ADA guidelines, only 51% fulfilled the full acceptance criterion.[18] The suggested reasons for the inconsistent retention rate of two-step etch&rinse adhesives are to form a less-optimal hybrid layer and to leave more residual solvent in the adhesive layer when compared to three-step etch&rinse adhesives. Those properties can result in increased hydrolytic degradation over time.[29-30]

In the current study, AP showed a completely favorable retention rate (100%), regardless of the presence of retention form. Other studies, in which retention form was not used, have reported various retention rates of AP. Brackett and others reported a 24% loss of retention after six months and 35% after one year.[31] Friedl and others reported retention loss rates of 16% after two years.[32] Van Dijken reported a loss of retention of 3.9%, 13.5%, 15.4% and 21.2% after 6, 12, 18 and 24 months, respectively.[33] There were also reports of a favorable AP retention rate. Munoz and others reported a 95% retention rate after three years,[34] while Boghosian and others reported a 96% retention rate after one year.[35] Bittencourt and others applied AP in two layers and reported a 93% retention rate after 18 months.[36] In the current study, AP was applied in two layers and attention was paid to solvent removal before curing, which was similar to the protocol used by Bittencourt and others. The high retention rate of AP in the current study might be attributed to this careful two-layer application. Such a protocol would prevent the forming of a dry spot, which could produce an area without optimal hybridization and lack of sufficient resin saturation in the upper hybrid layer.[28,37-38] Another reason for the high retention rate of AP in the current study may be related to enamel beveling and removal of sclerotic dentin. These treatments may facilitate the self-etching effect of AP on surfaces resistant to etching, such as unprepared enamel and sclerotic dentin.

Despite the high retention rate of AP, the marginal adaptation score of AP over two years was significantly worse than MP. This result might be explained by *in vitro* study results showing that the enamel bond strength and shear fatigue limit of AP were generally lower than multi-step etch&rinse adhesives.[39-42] The discordant results in retention rate and marginal adaptation of AP may also reflect the relatively short-term observation period of the current study. The inferior marginal adaptation of AP needs to be investigated for a longer time to determine how it affects the retention of restorations.

It had been widely believed that, when the bonded interface failed, it would be better to lose the restoration rather than to hold it in place by retentive points in order to prevent secondary caries. Based on this conventional belief and the high bond strength of dental adhesives, there is a general trend of not preparing macro-mechanical retention form for NCCL Class V resin restorations; however, no clinical study on the clinical effectiveness of retention form on NCCL Class V resin composite restorations was found. The current study showed significant beneficial effects of retention form on the retention rate of EX and the marginal discoloration of all three adhesives. Retention form applied for NCCL restorations might play important roles in resisting tooth flexure and polymerization shrinkage. First, resin composites placed in the retention form might improve mechanical interlocking with the tooth substrate and, subsequently, resist tooth flexure more effectively.[43] There may be a decrease in the accumulation of fatigue stresses resulting from repetitive tooth flexure on the less stiff adhesive layer than on the stiffer resin composite. Second, resin composites placed in the retention form might also play a role in resisting polymerization shrinkage, thus decreasing the marginal gap and subsequent marginal leakage.[20-21] Third, the increased adhesion surface provided by prepared retention form might also be advantageous to the clinical performance of resin composite restorations.

Considering that long-term leakage-free margins of NCCL Class V resin composite restorations cannot be guaranteed by contemporary adhesive systems,[44] it is noteworthy that preparing the retention form on the NCCL can provide a clinical performance of less marginal discoloration in adhesive restorations. Although it has been suggested that the retention of adhesive restorations for a reasonable time is no longer a clinical problem,[44] protecting the margins of adhesive restorations against marginal breakage and minimizing marginal discoloration still remain the greatest challenges of adhesive restorations. Marginal leakage and consequent marginal discoloration, instead of abrupt retention loss, might also be a reason for the shortened clinical longevity of NCCL Class V resin composite restorations. Clinicians should not only follow the correct adhesive bonding procedures, but they should also make efforts to closely match the margin of the NCCL cavity with that of the restoration. Thin extended portions of resin composites over the NCCL margin can be easily fractured and cause eventual margin problems. For successful retention and high marginal quality of NCCL Class V resin composite restorations, clinicians should also be familiar with the results of clinical trials

and *in vitro* studies according to the kinds of adhesives, bonding protocol and cavity configuration.

In the current study, it is difficult to determine which retention form is necessary for the higher retention rate of adhesive restorations, because only EX showed an improved retention rate with retention form; the other adhesive groups, MP and AP, showed a high retention rate, irrespective of retention form. Longer-term clinical evaluations are needed to confirm the effectiveness of the retention form on the retention rate of NCCL resin composite restorations.

CONCLUSIONS

Based on the two-year prospective randomized controlled clinical trial, it could be concluded that:

1. ScotchBond Multi-Purpose, a three-step etch&rinse adhesive, was found to have significantly superior marginal adaptation to Adper Prompt, a one-step self-etch adhesive.
2. Restorations with retention form showed a significantly higher retention rate in an experimental adhesive of two-step etch&rinse adhesives but not in the other adhesive groups and significantly less marginal discoloration in all three adhesives compared to those without retention form.

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