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Clinical Evaluation of Three Adhesive Systems for the Restoration of Non-carious Cervical Lesions

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Clinical Relevance

When esthetics is not critical, resin modified GIC is the best material for restoring non-carious cervical lesions. For highly esthetic restorations, self-etching primer with resin composite is the best material.

SUMMARY

The use of adhesive materials to restore non-carious cervical lesions (NCCL) has become the standard practice. Until recently, the most reliable material for restoring NCCL is glass ionomer cement, but the esthetics can be problematic. This study compared the retention of a self-etching adhesive, Clearfil SE Bond, with Clearfil ST resin composite (SE), with the phosphoric acid-etch single bottle adhesive Single Bond with A110 resin composite (SB) and a resin-modified glass ionomer cement, Fuji II LC, (FJ). Ninety-two restorations in 20 patients (mean age 61 years) were placed. The teeth were restored randomly and manufacturers' instructions were followed. Patients were recalled at 6 months, 1, 2 and 3 years and the restorations were evaluated for marginal staining. The restorations were photographed at baseline and at recall periods. At one year, 80 restorations were available for evaluation; at 2 years, 65 restorations were evaluated and at 3 years, 55 restorations were evaluated. The cumulative retention rates at 1 year, 2 years and 3 years, respectively, were SE: 97%, 93%, 90%; SB: 86%, 77%, 77%; FJ: 100%, 100%, 97%. At 3 years, RM-GIC performed the best, followed by Clearfil SE Bond/Clearfil ST. Single Bond/A110's performance was significantly less than the other 2 materials (p=0.012).

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INTRODUCTION

The etiology of non-carious cervical lesions (NCCL) is still unclear, but their prevalence is increasing as the population continues to age. Often, these lesions need to be restored due to sensitivity, esthetic considerations or because of the need to provide a tooth surface on which to place a partial denture clasp. Restoring an NCCL can be completed by either using a glass-ionomer cement (GIC) or resin composite with a resin-based adhesive. The reason for selecting either material is frequently based on practitioner choice or ease of material use without strong, clinically-based evidence demonstrating which material provides more durable restorations.

Clinical trials of GIC materials, either conventional or resin-modified, have shown good long-term results.[1-3] The advantage of the resin-modified GIC (RM-GIC) is improvement in esthetics and the ability to polish the restoration at the time of insertion. In addition, the release of fluoride may provide some protection of the tooth surface against developing caries; however, the

clinical data are equivocal.[4] The disadvantage to using a GIC is that it has weaker physical properties compared with resin composite and also poorer esthetics and a limited range of shades.

Resin-based adhesives have recently shown considerable improvement in the retention of restorations placed in NCCL. However, there is a vast range of adhesives available from which to choose, including the older three-step systems that use a separate etch, primer and bond, to the most recent innovation of the so-called "all-in-one" systems that have combined the three steps into a single process.[5] All of these systems have been evaluated with a variety of success.[6-9] Recently, the two-step self-etching primer systems have gained wide popularity due to their ease of use and purported lack of technique sensitivity.[10-11] These systems use an etching-priming solution, followed by a separate adhesive. Few clinical trials of greater than two years have been published which provide evidence as to whether self-etching systems perform better than the other adhesive systems available.[12-15] The self-etching materials tested have all shown good clinical results and high retention rates of restorations. However, no studies have compared resin-based self-etching systems with glass-ionomer cement restorations.

The basis for adhesion of the two-step self-etching primer and all-in-one systems is the use of an acidic resin to demineralize the enamel and dentin, while it also primes. The all-in-one systems also include the bonding process in the single solution. Laboratory studies have demonstrated the capability of self-etching systems to bond equally as well as phosphoric acid-etch based systems, which demineralize the tooth surface and require a wash and dry step prior to resin application.[4,7,16] However, the self-etch systems have been reported to etch enamel less effectively than phosphoric acid, which clinically can lead to marginal staining.[17] This is especially the case for enamel that has not been prepared.[17] Most of these findings, however, are based on laboratory studies. A similar problem—etching the dentin of NCCL—has also been suggested, as phosphoric acid etching based systems are known to create a much thinner hybrid layer on sclerotic, hypermineralized dentin seen on the surface of NCCL.[18-19]

There does not appear to be any published studies that make a direct comparison of an RM-GIC, a two-step self-etching primer adhesive and a phosphoric acid etch single-bottle adhesive when used to restore NCCLs. This study compared retention, shade match and marginal staining of restorations randomly placed in NCCLs using either an RM-GIC, a two-step self-etching primer adhesive or a phosphoric acid etch single-bottle adhesive in the same group of patients. The null hypothesis is that there is no difference in retention, shade match or marginal staining in teeth restored using the three systems.

METHODS AND MATERIALS

Ninety-two NCCLs were restored in 20 patients, with a mean age of 61 years. Ethical approval was granted from the Dental Health Services Victoria Review Committee, and patients' written informed consent was obtained prior to commencement of any treatment. Patients were excluded from the study if they exhibited severe periodontal disease or poor gingival health, had medical problems preventing them from attending for review appointments or exhibited rampant caries. The NCCLs selected were of varying sizes among the patients, with some lesions being quite shallow (~1 mm deep) to extensive lesions, up to ~3 mm deep. The materials used to restore the NCCLs are listed in Table 1. The lesions were randomly, but consecutively restored with each of the materials until the 92 restorations had been obtained. When a patient presented, the teeth were restored, commencing in the upper right quadrant, followed by the upper left, lower left and finally the lower right quadrant, using FDI notation for tooth identification. For a new patient, the material used to restore the first tooth was taken from the list for the next restoration. Whenever possible, each material was used to restore three lesions per patient, in some cases, more or less lesions were restored and not always in equal numbers.

Lesions were restored according to the manufacturers' instructions (Table 1) as follows: the lesions were cleaned with a slurry of pumice and water on a slowly rotating rubber cup in a slow-speed handpiece; they

Table 1: *Materials Used in the Study*

Material	Batch #	Manufacturer	Application
Cavity Conditioner	0009071	GC International Corp, Tokyo, Japan	Place cavity conditioner 20 seconds, wash/dry, place Fuji II LC, light cure 40 seconds
Fuji II LC	A 2 - 0101241 A 3.5 – 0011283		
Single Bond	20010809	3M-ESPE, St Paul, MN, USA	Etch surface 10 seconds, wash/dry, apply 2 coats of Single Bond, air thin, light cure 10 seconds, apply A110
Filtek A110	A3 - 20010803 A3.5 - 20010727		
Clearfil SE Bond	Primer – 00213A Bond - 00223A	Kuraray Medical Inc, Tokyo, Japan	Apply primer 20 seconds, dry, apply bond, air thin, light cure 10 seconds, apply ST
Clearfil ST	A 3.5 – 009HB		

Table 2: *Distribution of Teeth and Materials*

		Anterior			Premolar		Molar
	Fuji II	**SE Bond**	**Single Bond**	**Fuji II**	**SE Bond**	**Single Bond**	
Upper	10	9	8	5	3	9	1 (SE)
Lower	6	8	6	10	9	6	1 (SE)
							1 (SB)
92	16	17	14	15	12	15	3

Table 3: *Number of Restorations Evaluated at Recall, Number of Restorations Not Evaluated and Cumulative Retention Rate of Restorations*

Observation Period	**Start of Observation Period**	**End of Observation Period**		
	# of Restorations	**Restorations Unable to be Evalualated**	**Restoration Lost During Observation Period**	**Cumulative Retention of Restorations (%)**
Fuji II LC				
0-1 years	31	5	0	100
1-2 years	26	5	0	100
2-3 years	21	0	1	97
Single Bond/Filtek A110				
0-1 years	30	3	4	86
1-2 years	23	5	3	77
2-3 years	15	0	0	77
SE Bond/Clearfil ST				
0-1 years	31	4	1	97
1-2 years	26	6	1	93
2-3 years	19	0	1	90

were then washed and dried, but not desiccated. Next, the teeth were randomly selected, with 30 or 31 restorations placed for each material. The resin composite was placed in bulk and light-cured for at least 40 seconds. Larger lesions were filled in two increments, each increment was cured for 40 seconds. For the RM-GIC, the cured restorations were coated with Single Bond that was light-cured before and after polishing to prevent desiccation. The restorations were contoured using fine finishing diamonds in a slow-speed handpiece under water spray and polished with Soflex discs (3M-ESPE, St Paul, MN, USA). It was typical for each patient to receive at least one restoration using each adhesive system. In several cases, multiple restorations were completed in a patient with an equal distribution of the materials, if possible. The lesions were consecutively restored with each of the adhesive systems, ensuring that lesion size and location was random. The restorations were placed by both authors, who have extensive experience with similar clinical trials. The first author, however, has been using self-etching systems since their development; whereas, the second author has had less experience using such systems.

Photographs of the lesions and the final restorations (baseline) were taken at 1:1 magnification using color slide film. The patients were recalled at 6 months and at 1, 2 and 3 years; the presence or absence of the restoration was recorded and additional 1:1 color photographs taken. At each time interval, color match of the restoration to the tooth and the presence or absence of marginal discoloration was assessed by the second author without knowledge as to which author placed the restorations. This was done based on assessment of the photographs against a set of standard photographs. The cumulative retention of restorations was calculated for the 3 years of the study using survival analysis.[20] Retention was defined as the restoration being present or absent at the recall visit. No intra-individual comparison was performed, as the number of restorations placed in individuals was not deemed great enough to make the comparison meaningful. Statistical analysis of restoration survival was performed using the Kaplan-Meier method.

RESULTS

Table 2 lists the distribution of restorations to teeth, with most of the teeth being anterior teeth or premolars. Evaluation and recall rates of the restorations are shown in Table 3. At one year, 80 restorations were evaluated; at 2 years, 65 restorations were evaluated and 55 restorations were evaluated at three years. The main reason for patients dropping out of the study was an inability to be contacted or consistent failure to return for recall. One patient was also deceased.

RM-GIC performed best over the three years of the study, with a cumulative retention rate of 97%. SE Bond showed a retention rate of 90%, and Single Bond showed the poorest rate of retention of only 77% at 3 years.

Marginal staining was evident around one restoration each of Single Bond and Fuji II LC at two years, and one restoration of Single Bond and two of SE Bond at three years. The degree of staining was minimal, being of no concern to the patient, except for one restoration

with Single Bond/A110 at three years. This restoration showed significant marginal discoloration to the extent that restoration replacement would be considered.

Color match was excellent for SE Bond/Clearfil ST and Fuji II LC restorations throughout the study. When A110 was used, it was noted that the shade was frequently too light. However, the shade mismatch was not so great as to cause concern to patients.

Statistical analysis showed the failure rate of Single Bond was statistically worse than Fuji II LC (p=0.012). A comparison of the other materials demonstrated no differences in failure rate (p>0.05).

DISCUSSION

This study is one of the first clinical trials to use the same patient pool to compare two resin-based adhesives and an RM-GIC that uses different methods for bonding to NCCL. It shows that there does seem to be some difference among the retention rates of the materials tested, with the worst being the phosphoric acid etch material, Single Bond. It would appear that the reliability of this adhesive is less than the other two materials tested, but this observation must be viewed with some caution due to the number of restorations that could not be reviewed at the three-year recall. It was interesting to note that the phosphoric acid etch material also exhibited one restoration with the greatest marginal discoloration. The other materials, Fuji II LC and SE Bond, also exhibited marginal discoloration but to a much lesser and not clinically relevant degree.

The results of this study compare favorably with similar studies that compared phosphoric acid etch or self-etch resin-based adhesives.[9,14-15] There is no recent report that has compared resin-based self-etching adhesives with an RM-GIC. Most of the other studies also used phosphoric acid to etch enamel when the self-etching primer adhesive was used, with few data making a direct comparison of resin-based adhesives and GICs.[14-15]

A study by Peumans and others[15] compared the effect of pre-etching a beveled enamel margin on cervical restorations bonded with Clearfil SE Bond. The authors showed a 100% retention rate at three years and better marginal integrity for the etched group. The Peumans and others[15] study showed that there was a slightly smaller "clinical success rating" of 98% for the non-etched group. The current study showed a cumulative retention rate for SE Bond of 93% at two years. The lower figure in the current study probably related to the different method used to prepare the teeth prior to restoration, such as not placing an enamel bevel. To ensure reliable retention with a self-etching priming adhesive, an enamel bevel and phosphoric acid etching seems best. However, in the current study, phosphoric acid-etch adhesive and the self-etching primer systems did not show this outcome, and more restorations showed marginal staining with the phosphoric acid etch based system.

Recent studies evaluating RM-GICs have shown varied results. A five-year evaluation of Fuji II LC and a polyacid-modified resin composite showed that the composite performed better for color match, surface texture, marginal integrity and discoloration; however, there were a small number of restorations, hence, making definitive conclusions difficult.[21] A study by Smales and Ng[22] also compared polyacid-modified resin composite with Fuji II LC in a general dental practice setting. That study showed a "zero per cent cumulative survival" up to five years for Fuji II LC, based on failure due to surface and marginal loss of material, dislodgement and discoloration. The polyacid-modified resin composite was only marginally better at 14.9% survival. These results differ markedly from the results of the current study, in which Fuji II LC performed the best; however, the criteria for failure in this study differ from that of Smales and Ng.[22] The retention rate was highest (97%) at 3 years; there was minimal marginal staining and the surface integrity of the restorations was also regarded as satisfactory. This might have been due, in part, to the restorations being covered with a layer of light-cured resin (Single Bond) after polishing. This coating afforded the restorations protection against desiccation, and the resin also filled porosities on the surface.

The only other study that has compared resin-based adhesives and RM-GIC was by van Dijken,[8] who used EBS (ESPE, Oberbay, Germany) and One-Step (BISCO, Schaumburg, IL, USA) with Fuji II LC. Both bonding systems were phosphoric acid etch systems. At 36 months, the cumulative losses were 49% for One Step, 10% for EBS and 7% for Fuji II LC. The results of the current study compare very closely to the results of this study by van Dijken with regard to the RM-GIC.

Single Bond had 1 restoration that showed very obvious marginal staining, while the other two materials showed two restorations, each with detectable staining that was not of a concern to the patient. A study by Santini and others[23] showed that no matter what type of system was employed (phosphoric acid etch compared with self-etch), and whether or not a bevel was placed, microleakage was still observed. This seems to have been the case in this clinical trial. Some leakage was located at the gingival margin for the resin-based systems. This was most likely due to crevicular fluid seeping onto the cured adhesive, or again, a slight flash of composite extending beyond the bonded tooth surface. The number of restorations that showed marginal staining was so few and at various sites (gingival vs occlusal) with no relation to bonding system, that it was not analyzed further.

CONCLUSIONS

In conclusion, RM-GIC performed the best out of the three materials tested, with the self-etching priming material also showing good outcomes. The phosphoric acid-etch system and microfilled resin composite showed a relatively high failure rate in the first two years and stabilized thereafter. When a highly esthetic outcome is desired, the self-etching priming-resin composite combination would seem to be the material and method of choice.

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