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Clinical Research

5-year Clinical Performance of Resin Composite Versus Resin Modified Glass Ionomer Restorative System in Non-carious Cervical Lesions

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Clinical Relevance

A long-term evaluation of the materials' behavior is relevant for Class V restorations in which clinical performance is particularly challenging.

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SUMMARY

Aim: To comparatively assess the 5-year clinical performance of a 1-bottle adhesive and resin composite system with a resin-modified glass ionomer restorative in non-carious cervical lesions. Method and Materials: One operator placed 70 restorations (35 resin modified glass ionomer restorations and 35 resin composite restorations) in 30 patients under rubber dam isolation without mechanical preparation. The restorations were directly assessed by 2 inde-

pendent examiners, using modified USPHS criteria at baseline and 6, 12, 24 and 60 months. Results: Twenty-two patients were available for recall after 5 years (73.3% recall rate) and 55 out of 70 restorations were evaluated. Excellent agreement was registered for all criteria between examiners (kappa ≥0.85). Sixteen composite restorations were dislodged (51.5% retention) and 1 ionomer restoration was lost (96.4% retention). The McNemar test detected significant differences in resin composite restorations between baseline and 5-year recall for marginal integrity (p<0.001) and retention (p=0.004). For resin modified glass ionomer restorations, no significant differences were identified for all criteria (p>0.05). When comparing both materials, the Fisher exact test pointed out significant differences in retention (p=0.002) after 5 years of clinical service. Conclusions: After 5 years of evaluation, the clinical performance of resin modified glass ionomer restorations was superior to resin composite restorations.

INTRODUCTION

In clinical practice, the restoration of non-carious cervical lesions is a challenge, because, most of the time, the cervical margin is located in cementum or dentin. This characteristic makes the cervical margin more susceptible to microleakage, causing cavosurface stains, postoperative sensitivity and also favors the incidence of caries lesions. Additionally, the quality of dentin in these lesions is sclerotic or vitrified in a majority of cases. The adhesive quality of sclerotic dentin is lower than non-sclerotic dentin due to a distinct pattern of acid etching in highly mineralized tissue (Yoshiyama & others, 1996; Tay & Pashley, 2004). Therefore, the clinical performance of restorations placed in non-carious cervical lesions is expected to be more critical, especially in long-term evaluations.

Numerous studies have investigated the clinical behavior of non-carious cervical lesions restored with resin composite and glass ionomer cement. However, many clinical trials are short-term evaluations (up to 2 years of follow-up), where both resin composite and glass ionomer restorations perform well (Powell, Gordon & Johnson, 1992; Abdalla & Alhadainy, 1997; Brackett & others, 2002; Ermis, 2002; Türkün, 2003). Even after 3 years of clinical service, there is no evident distinction in the overall performance of both restorative systems, other than lower retention rates for resin composite restorations (Powell, Johnson & Gordon, 1995; Neo & others, 1996; Burrow & Tyas, 1999) and poor color stability for glass ionomer restorations (Duke & Trevino, 1998; Özgünaltay & Önen, 2002).

Nevertheless, upon analyzing the literature, it is clear that resin composite tends to fail with time. Compared to glass ionomer restorations, the retention rates for such restorations are markedly lower when longer evaluation periods are used (van Dijken, 1994; Duke & Trevino, 1998). These data call for longer evaluation periods in clinical trials. A 5-year follow-up of resin modified glass ionomer restorations verified better marginal adaptation, higher retention rates and lower marginal discoloration when compared to compomer restorations (Loguercio & others, 2003), thus indicating the promising performance of this material in non-carious cervical lesions at long-term evaluation.

Long-term evaluations are especially interesting when considering the behavior of 1-bottle or primer adhesives. Simplified adhesives are frequently used due to the simplicity in handling and reduction in operative steps. Currently, some problems have been identified with this category of adhesive system, including permeability (Tay & others, 2004) and hydrolysis. Thus, this study assessed the 5-year clinical performance of a 1-bottle adhesive and resin composite system compared with a resin-modified glass ionomer restorative in non-carious cervical lesions.

METHODS AND MATERIALS

Patient Selection

Following the guidelines of the Committee of Ethics in Research (approved in 2/24/2000), 30 volunteers (18 to 50 years old) were instructed on the conditions and objective of the study, and they signed informed consent forms and authorizations to participate in this investigation. Inclusion criteria were: good oral hygiene, no periodontal disease or deleterious habits and the presence of at least 2 non-carious cervical lesions. All lesions were no less than 1-mm deep and independent of their location in the dental arch. Each patient received at least 1 resin composite and 1 resin modified glass ionomer restoration, for a total of 70 restorations. Seventy percent of the restorations were located in the upper arch, while 30% were in the lower arch. Eighty percent of the restorations were placed in premolars, 10% in molars and 10% in anterior teeth.

Restorative Procedures

All restorations (35 for each restorative material) were performed by the same operator. Twenty-six patients received 2 restorations, 3 patients received 4 restorations and 1 patient received 6 restorations. No cavity preparation was carried out. Enamel margins were not beveled and no mechanical retention was placed. A rubber dam was used in all situations, and the cavities were pumiced prior to restorative intervention.

For resin composite restorations, enamel and dentin were etched for 30 seconds with 37% phosphoric acid gel (Total Etch, Ivoclar Vivadent, Schaan, Liechtenstein), washed for 30 seconds and dried gently. Absorbent paper was used to remove the excess water.

One coat of the 1-bottle adhesive system (Excite, Ivoclar Vivadent) was applied to the visibly moist dentin surface and brushed gently for 10 seconds. An air blast was applied to favor evaporation of the alcohol solvent, and primer adhesive was light-cured for 20 seconds. Resin composite (Tetric Ceram, Ivoclar Vivadent) increments were inserted and light-cured for 40 seconds using a calibrated light-curing unit (XL 3000, 3M ESPE, St Paul, MN, USA) at 600mW/cm^2. Excess composite was immediately removed using a #12 blade. Finishing and polishing was performed 1 week later using 12-fluted tungsten carbide burs, abrasive cups (Enhance, Dentsply Caulk, Milford, DE, USA) and disks (Sof-Lex polishing disks, 3M ESPE).

The resin-modified glass ionomer cement (Vitremer, 3M ESPE) was used according to the manufacturer's instructions. Primer was applied to the surface of the lesion for 30 seconds using a micro brush. Light curing was conducted for 20 seconds using the same calibrated device. Glass ionomer cement was manipulated in a 1:1 powder/liquid ratio and inserted using disposable tips and syringe. The restoration was light cured for 40 seconds and excess material was immediately removed using a #12 surgical blade. Finishing and polishing were carried out in a similar way to the resin composite restorations 1 week after the restorations were placed.

Clinical Evaluation

Two independent, calibrated examiners, other than the operator, were responsible for the clinical evaluations. Although the double-blind design was originally assigned, it was sometimes possible for the examiner to identify which material was used for the restoration. Modified United States Public Health Service criteria (Ryge, 1980) were used to evaluate retention, marginal integrity, marginal discoloration, anatomic form and secondary caries (Table 1) at baseline and 6, 12, 24 and 60 months. The baseline rating was carried out 1 week after restoration, immediately after finishing and polishing procedures.

Statistical Methods

Inter-examiner agreement was assessed using kappa. For all criteria, excellent agreement was registered between both examiners (retention: kappa=1.00; marginal integrity: kappa=0.95; marginal discoloration: kappa=0.85; secondary caries: kappa=1.00). Intra-group comparisons between baseline and other evaluation periods within the same material were performed by McNemar test (α=0.05). Inter-group comparisons to identify differences between restorative materials at each period were conducted by Fisher exact tests (α=0.05).

RESULTS

Recall rates registered were 100% for baseline, 6 and 12 months (n=30), 93.3% for 2 years (n=28) and 73.3% after 5 years (n=22). The recall rates registered overcame the minimum requirement of the ADA guidelines for subject size in clinical trials for restorative materials, which states that a minimum of 20 patients must be available for the 2-year recall and 15 patients must be examined at the 4-year evaluation.

Table 2 presents data for retention, marginal integrity, marginal discoloration, anatomic form and secondary caries for all evaluation periods. The numbers in parenthesis indicate the total number of restorations classified as clinically acceptable (Alpha and Bravo ratings) in each evaluation period versus the total number of restorations assessed at that time period. All restored sites were considered for the retention criteria, and dislodged restorations were counted as failures in all subsequent recalls. Only assessed restorations were used as references to calculate the percentage values for marginal integrity, marginal discoloration, anatomic form and secondary caries.

All patients were available for recall at 6 and 12 months and all 70 restorations could be assessed. Although 4 resin composite restorations were lost at 6 months and 1 extra restoration was lost at the 1-year

Table 1: *Modified USPHS Criteria Rating System*

Category	Rating	Criteria
Retention	Alpha (A) Charlie (C)	Restoration is present. Restoration is partially or totally lost.
Marginal Integrity	Alpha (A) Bravo (B) Charlie (C) Delta (D)	No visible gap in which the explorer will penetrate. There is visible gap, the explorer will penetrate or catch. The explorer penetrates the gap and dentin or base is exposed. The restoration is mobile, partially or totally fractured or lost.
Marginal Discoloration	Alpha (A) Bravo (B) Charlie (C)	No discoloration. Discoloration is present but has not penetrated along the margin. Discoloration has penetrated along the margin.
Anatomic Form	Alpha (A) Bravo (B) Charlie (C)	Restoration is continuous with existing anatomic form. Restoration is discontinuous with existing anatomic form, but dentin or base is not exposed. Sufficient material is lost to expose dentin or base.
Secondary caries	Alpha (A) Charlie (C)	No caries is present at the margin of the restoration. There is evidence of caries at the margin of the restoration.

Table 2: *Clinical evaluation of resin composite and resin modified glass ionomer restorative systems. Percentages of clinically acceptable ratings (Alpha and Bravo) for retention, marginal integrity, marginal discoloration, anatomic form and secondary caries.*

Category	Material	Baseline	1 Year	2 Years	5 Years
		% A+B	% A+B	% A+B	% A+B
Retention	RC	100% (35/35)	85.7% (30/35)	78.8% (26/33)	51.5% (27/33)
	RMGI	100% (35/35)	100% (35/35)	100% (33/33)	96.4% (27/28)
		p=1.00	p=0.054	p=0.011*	p=0.002*
Marginal Integrity	RC	97.2% (34/35)	100% (30/30)	100% (26/26)	76.5% (13/17)
	RMGI	100% (35/35)	100% (35/35)	100% (33/33)	85.2% (23/27)
		p=1.00	p=1.00	p=1.00	p=0.690
Marginal Discoloration	RC	100% (35/35)	100% (30/30)	100% (26/26)	100% (17/17)
	RMGI	100% (35/35)	100% (35/35)	100% (33/33)	100% (27/27)
		p=1.00	p=1.00	p=1.00	p=1.00
Anatomic Form	RC	100% (35/35)	96.6% (29/30)	96.2% (25/26)	88.2% (15/17)
	RMGI	100% (35/35)	100% (35/35)	100% (33/33)	85.2% (23/27)
		p=1.00	p=0.462	p=0.441	p=1.00
Secondary Caries	RC	100% (35/35)	100% (30/30)	100% (26/26)	88.2% (15/17)
	RMGI	100% (35/35)	100% (35/35)	100% (33/33)	100% (27/27)
		p=1.00	p=1.00	p=1.00	p=0.144

RC = Resin Composite (Excite/Tetric Ceram, Vivadent)
RMGI = Resin Modified Glass Ionomer Cement (Vitremer, 3M ESPE)
**Indicates significant differences between tested materials for that criterion.*

assessment, no significant differences were detected in all criteria for both materials during these times.

At the 2-year recall, 2 patients could not be found; as a result, 66 restorations were assessed. Seven composite restorations were lost, while no ionomer restoration was lost. When comparing resin composite and resin modified glass ionomer restorations at 2-year recall, the only significant difference was for retention criterion (p=0.011).

At the 5-year recall, 22 volunteers returned for evaluation. Fifty-five out of 70 restorations were evaluated (27 resin composite restorations and 28 resin modified glass ionomer restorations). Sixteen composite restorations were considered to be failures at this evaluation period (51.5% retention), while only 1 ionomer restoration was lost (96.4% retention). The McNemar test detected significant differences for resin composite restorations between baseline and 5-year recall for marginal integrity (p<0.001) and retention (p=0.004). For resin modified glass ionomer restorations, no significant differences were identified for all criteria (p>0.05). When comparing both materials, Fisher exact test pointed out significant differences for retention (p=0.002) after 5 years of clinical service.

DISCUSSION

One of the most important factors in the retention of restorations of non-carious cervical lesions is the bonding to cavity walls, because such cavities lack inherent macromechanical retention (Maneenut & Tyas, 1995). Adhesive materials such as resin composites, conventional or resin modified glass ionomer cements or polyacid-modified resin composites have been mostly used for this purpose.

This study investigated the clinical performance of a primer adhesive/resin composite system and resin modified glass ionomer cement. Retention was considerably lower for resin composite after 5 years when compared to resin modified glass ionomer restorations. These results are in accordance with earlier research (Maneenut & Tyas, 1995; Browning, Brackett & Gilpatrick, 2000).

Since no cavity preparation was performed, including enamel beveling, the true dentin bonding capacity of the restorative systems could be evaluated. Several researchers have used this experimental model to assess the clinical performance of materials in non-carious cervical lesions (Powell & others, 1992; van Dijken, 1994; Ermis, 2002).

The loss rate of composite restorations has always been problematic. The low retention rate of resin composite is possibly due to degradation of the adhesive bond. With former adhesive systems, lost composite restorations accounted for up to 80% of total restorations after 4 years (van Dijken, 1994). The development of new materials has shown an improvement in these figures. However, the results of this study confirm that resin adhesion in dentin is far from ideal, even with more modern adhesive systems. The confidence placed in simplified adhesive systems is now being reviewed. Others studies have confirmed that 1-bottle adhesives have exhibited satisfactory retention rates (80% to 93%) during the first 2 years of evaluation (Merte & others, 2000; Brackett & others, 2002; Türkün, 2003; van Dijken, 2004); however, the number of lost restorations

after 5 years of clinical service is significant. There is now evidence that 1-bottle adhesives behave as permeable membranes after polymerization, because they lack a comparatively greater hydrophobic bonding resin layer (Tay & others, 2004). Therefore, they allow for the continuous transudation of dentinal fluid and do not provide a hermetic seal of deep dentin (Tay & others, 2004), which may accelerate degradation of the adhesive interface.

Another challenge is the characteristic of non-carious cervical lesions. Sclerotic dentin and tubule occlusion by mineral crystals are present most of the time. Additionally, many parts of the wedge-shaped cervical lesion contain a hypermineralized surface that is resistant to acid etching. Indeed, these factors are responsible for the lower microtensile bond strengths verified in these types of lesions when compared to similar areas artificially prepared in normal teeth (Tay & Pashley, 2004).

Resin composite restorations failed at an ascending proportion. At 1-year recall, composite retention was reduced to 85.7%, while not a single ionomer restoration was lost. At the 2-year evaluation, retention for resin composite restorations was registered as 78.8%, whereas, retention for ionomer restorations was maintained. After 5 years, the retention rate for composite restorations decreased to 51.5%, while ionomer restorations was reduced to 96.4%. Similar results were described by Loguercio and others (2003), who found a 93% retention rate for resin modified glass ionomer restorations at the 5-year recall. According to the acceptance program guidelines for restorative materials (ADA, 1996), the failure rate of restorations cannot be higher than 5% at 2 years or 10% at 4 years.

The high retention index of Vitremer restorations may be attributed to their good mechanical properties and better adhesion to dental tissues (Sidhu & Watson, 1995; Yap & Neo, 1995). Vitremer possesses 2 adhesion mechanisms: first, an auto-adhesive capacity through the formation of ionic bonds between the carboxyl groups of polyalkenoic acid and hydroxyapatite (van Dijken, 2000) and, second, micromechanical interlocking of the polymer (van Meerbeek & others, 1998). The combination of these factors may have been responsible for the higher retention rate of this material (Loguercio & others, 2003).

Although resin modified glass ionomer cements present good retention rates in the literature, the major problem with this material is poor color stability (Maneenut & Tyas, 1995; Browning & others, 2000; Özgünaltay & Önen, 2002; Loguercio & others, 2003). This deficiency can be compensated for with a final increment of resin composite, which preserves color stability (Browning & others, 2000). In cases where esthetics are essential, sandwich restorations are a good alternative and seem to minimize restoration loss (Powell & others, 1992; Peumans & others, 2003).

The overall better behavior of ionomer restorations is in accordance with previous research at short- (Santiago & others, 2003; Duke & Trevino, 1998; Brackett & others, 2002) or long-term evaluations (Loguercio & others, 2003). Apparently, glass ionomer cement, light or chemically cured, continues to be the most retentive material for non-carious cervical lesions (Powell & others, 1995; Burrow & Tyas, 1999; Neo & others, 1996).

CONCLUSIONS

Despite the limitations of this study, the overall clinical performance of resin modified glass ionomer restorations was superior to the combination of 1-bottle adhesive and resin composite restorations after 5 years of evaluation.

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