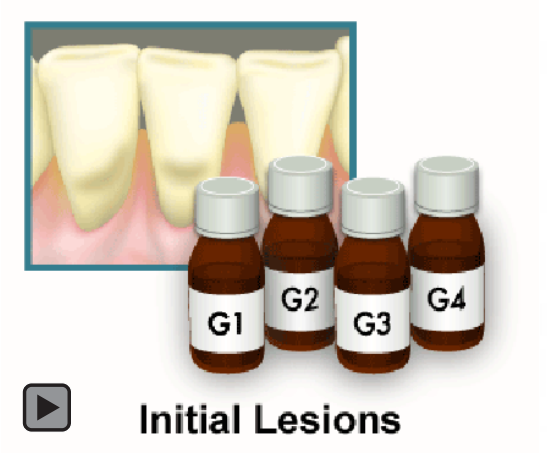
the Journal of CONTEMPORARY DENTAL PRACTICE at www.thejcdp.com
Volume 7 Number 5 November 1, 2006

One-Year Clinical Evaluation of Two Resin Composites, Two Polymerization Methods, and a Resin-Modified Glass Ionomer in Non-Carious Cervical Lesions

Stephen Koubi, DDS; Anne Raskin, DDS, PhD; Frédéric Bukiet, DDS; Christian Pignoly, DDS; Edwige Toca, DDS; Hervé Tassery, DDS, PhD



Abstract

Aim: The aim of this study was to examine clinically relevant data on four restorative procedures for non-carious cervical lesions using United States Public Health Service (USPHS)–compatible clinical and photographic criteria and to compare different methods of analyzing clinical data.

Methods and Materials: Fourteen patients with at least one or two pairs of non-carious lesions under occlusion and a mean age of 50 were enrolled in this study. A total of 56 restorations (14 with each material) were placed by three experienced, calibrated dental practitioners. Two other experienced and calibrated practitioners, under single-blind conditions, followed up on all restorations for a period of one year. Three materials were randomly placed: a micro-hybrid composite with two polymerization methods (G1 and G2), a flowable micro-hydrid composite (G3), and a resin-modified glass ionomer (G4). Statistical analysis was performed using the Kruskall-Wallis test ($p<0.05$) and a Mann-Whitney U modified test with a corrected significance level.

Results: At the one year evaluation time, there were no restorations with secondary caries and the retention rates in G1 (IntenS with a hard polymerization), G2 (IntenS with a soft polymerization), G3 (Filtek flow), and G4 (Fuji II LC) were 85.7% (two losses), 92.8% (one loss), 100%, and 100%, respectively. The total visual

comparison of the results at baseline (15 days later) showed significant differences only with the clinical acceptance criterion: G1 was different from G2, with a soft polymerization device ($p<0.05$). In terms of surface quality at one year, G1, G2, and G3 exhibited a statistically significant difference from G4, $p<0.05$. The digital analysis at baseline showed significant differences only with the clinical acceptance criterion: G1=G2 was different from G3=G4, $p<0.05$. At one year, only the microporosity criterion showed any statistical differences: G1=G2=G3 was different from G4, $p<0.05$.

Conclusions: The resin-modified glass ionomer was easier to use and had a high retention rate, but it failed in terms of surface quality (visual mode) and porosity (digital mode) criteria compared to the others groups. Overall results showed no difference between groups G1 (hard-polymerized) and G2 (soft-polymerized), and only G1 was affected by the marginal edge ($p<0.03$) and integrity criteria ($p<0.02$) at one year.

Keywords: Non-carious cervical lesion, polymerization methods, visual and digital analysis

Citation: Koubi S, Raskin A, Bukiet F, Pignoly C, Toca E, Tassery H. One-Year Clinical Evaluation of Two Resin Composites, Two Polymerization Methods, and a Resin-Modified Glass Ionomer in Non-Carious Cervical Lesions. J Contemp Dent Pract 2006 November;(7)5:042-053.

Introduction

It is not uncommon for patients to exhibit dental lesions or defects which are classified as non-carious cervical lesions. These include three different lesion categories: abrasion, erosion, and abfractions involving a multi-factorial etiology previously reviewed by others.[1-4] Abrasion is wear caused by some physical agent applied to the teeth.[2] Toothbrush abrasion is common, especially if the brush has stiff bristles and is used in conjunction with highly abrasive toothpastes. This can be accentuated by traumatic occlusion or the flexing of the teeth resulting in the flaking away of cervical enamel which is referred to as an abfraction lesion.[2,5] Erosion is tooth wear involving a chemical dissolution of the mineralized dental tissues caused by several behaviors, the more common of which is a continuous intake of low pH soft drinks or sucking on acidic fruits.[6] Some estimates suggest nearly one-third of the adult population is affected by some level of abrasion.[7]

Due to different diets and lifestyles, young people present a wide variety of cervical lesions[6] increasing the need for treatment either because of esthetics, hypersensitivity, or food impaction. These types of lesions, in addition to pathological wear, can result in the formation of reactionary and reparative dentin and the obstruction of dentinal tubules by mineral deposits.[8]

These events can substantially modify or even jeopardize bonding between mineralized tooth tissues and restorative materials as reported extensively in the dental literature.[9-12] Cofactors such as the saliva[13], its pH, the restoration volume, the influence of the occlusal patterns[14], the restoration shape, and the depth of the initial lesion[2] can influence the long-term success of the non-carious lesion restoration.[15] As a result, a comparison of various restorative procedures for non-carious dental lesions is warranted. Here the comparison will include the following: a micro-

Abrasion

Erosion

Abfraction

hybrid dental composite with a low skrinkage value (G1), the same composite with a modified light polymerization sequence (G2),[16] a flowable micro-hybrid composite (G3), and a resin-modified glass ionomer (G4). In this study twelve factors were checked and analyzed to determine their influence on the thirteen following criteria:

1. Number of teeth with cavities filled except in the cervical area.
2. Number of teeth with caries except in the cervical area.
3. Median dental mobility value.
4. Median daily teeth cleaning value.
5. Median lesion depth.
6. Median saliva pH value.
7. Median restoration wax weight.
8. Median saliva temperature value.
9. Median number of working contacts.
10. Median number of nonworking contacts.
11. Median number of worn facets per tooth.
12. Number of regurgitations per day.
13. Number of soft drinks per day.

This study was undertaken to: (1) examine the clinically relevant data from four restorative procedures for non-carious cervical lesions using United States Public Health Service (USPHS)–compatible clinical and photographic criteria[17], (2) compare visual and photographic analysis of the clinical data, (3) analyze the various clinical cofactors observed, and (4) offer dental practitioners a recommendation for the most effective clinical procedure for restoring non-carious lesions.

Methods and Materials

The project was supported by Assistance Publique, Hôpitaux de Marseille (APHM) and approved by the Marseilles, France ethics committee (CCPPRB: Comité Consultatif de la Protection des Personnes et de la Recherche Biomédicale). Fourteen patients, (4 females and 10 males), each with at least two pairs of non-carious lesions under occlusion (at least with a denture) with a mean age of 50 years old were enrolled in this study. A total of 56 restorations (14 in each group) were placed by three experienced, calibrated dental practitioners who were responsible for the primary treatment. Two other experienced and calibrated practitioners under single-blind conditions followed up on all restorations for a period of one year. The restorations were not placed on molars but on maxillary and mandibular premolars as well as anterior teeth using a non-split-mouth design.

Evaluation of Various Clinical Items and Cofactors

The USPHS modified clinical index is listed in Table 1 and the cofactor assessments are described below:

1. Number of teeth with cavities filled except in the cervical area.
2. Number of teeth with caries except in the cervical area.
3. Median dental mobility value.
4. Median daily teeth cleaning value.
5. Median lesion depth.
6. Median saliva pH value.
7. Median restoration wax weight.
8. Median saliva temperature value.
9. Median number of working contacts.
10. Median number of nonworking contacts.
11. Median number of worn facets per tooth.
12. Number of regurgitations per day.
13. Number of soft drinks per day.

To increase the power of the clinical evaluations the vestibular surface of each tooth was divided into four areas and all of the clinical parameters were applied to each of them. The score obtained for each parameter was the median value of the four surfaces evaluated per tooth.

Patients suffering from bruxism, poor hygiene, and pathological occlusal interference were excluded from this study.

Volume Assessment

The volume of each composite restoration was assessed using a simulated wax technique (Slaycris products, Portland, OR, USA) on a dental stone replica of the preparation (Fujirock GC, Tokyo, Japan). Each wax pattern

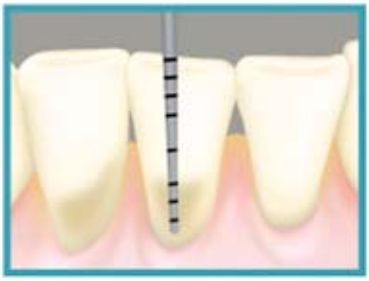
Table 1. USPHS-CP Index: Clinical and photographic coding of composite restoration. (*photographic criteria)

Color Match
0: Matches to adjacent enamel, glossy 1: Matches to adjacent enamel, not glossy 2: Very bright 3: Very dark
Surface Quality
0: Smooth, homogeneous surface 1: Smooth, non homogeneous surface 2: Rough, homogeneous surface 3: Rough, non homogeneous surface
Marginal Integrity (four areas per tooth)
0: Margin non detectable by probing 1: Margin detectable in fissure ramifications 2: Margin detectable in areas with no fissure 3: Margin detectable more than 1/3 of the circumference 4: Marginal leakage/gap
Marginal Edge* (four areas per tooth)
0: No marginal edge 1: Excess of filling material 2: Negative edge (exposed tooth margins) 3: Excess of filling material and negative edge
Wear* (four areas per tooth)
0: No loss of filling material 1: Localized loss of filling material according to individual patterns 2: Extensive loss of filling material
Marginal Discoloration* (four areas per tooth)
0: No discoloration 1: Visible discoloration in fissure ramification up to 1/3 of the circumference 2: Discoloration at more than 1/3 of the circumference 3: Secondary caries with detectable cavitation
Clinical Acceptance*
0: Excellent 1: Satisfactory 2: Acceptable after correction 3: Replacement for prevention 4: Not acceptable
Porosity*. 0, none; 1, obvious surface porosity

simulating the restoration was respectively weighed (Explorer Scale, d=1mg, OHAUS Corporation, Pine Brook, NJ, USA).

Lesion Depth

The depth of each lesion was measured using a periodontal probe (scale, Hu-Friedy, Leimen, Germany).



Saliva and Bacteriological Test Methods

Vivadent bacteriological and saliva tests were used (Denticult SM and SB, Dentobuff strip, Vivadent, Schaan, Liechtenstein, Producer: Orion Diagnostica, Finland) following the manufacturer's recommendations. The tests were performed at the

beginning of a treatment session or at a separate visit and at least one hour after a meal, brushing of the teeth, or smoking. It was important for the patient to be relaxed, calm, and feeling healthy. The patients must not have been taking any antibiotics over the course of the previous month.

Estimated 'Stimulated' Saliva Flow Rate

One hour prior to initiating the test, the subject was asked not to smoke or eat. The patient was seated in an upright relaxed position and given a paraffin pellet to chew for 30 seconds and asked to either expectorate or swallow the accumulated saliva. The patient continued chewing for five minutes with the accumulated saliva continuously being collected in a measuring cup. The time was reduced if the secretion rate was high or prolonged if the rate was low. The amount of saliva was measured after five minutes, and the secretion rate was calculated in ml/min.

Estimated Bacterial Counts in the Saliva

Dentocult SM and LB were used to estimate the *Streptococcus mutans* and *Lactobacilli* counts in the saliva. The method is based on the use of a selective culture broth and on the adherence of *Streptococci mutans* and *Lactobacilli* to test strips.

Streptococcus mutans

Lactobacilli

Evaluation of Saliva Buffer Capacity

Dentobuff Strip was used to determine the salivary buffering capacity. An indicator system incorporated into the test strip changes color, clearly showing the saliva's buffer capacity. An enclosed pipette was used to apply a drop of stimulated saliva to a test pad, which was enough to cover the entire pad. After a five minute reaction time, the test pad color was compared to the Dentobuff Strip Color Chart. This test system discriminates between low (yellow) and high (blue) buffer capacity.

Evaluation of the Salivary pH

Prior to restoring the non-carious cervical lesions, an amount of stimulated saliva was removed and the average saliva pH of each patient was measured at three different times using a temperature-dependent electronic pH meter (Pierron pH meter, ref: MTO4975-208, France).

Pre and Postoperative Sensitivity

This evaluation was conducted using the air blow test as previously described.[18] The patient was asked to score the level of pain on a visual analog pain scale from zero to ten.

Dentin Sclerosis Criteria

This evaluation was based on a dentin sclerosis scale with four categories, as described and modified by Swift et al.[19]

Category 1: No sclerosis present. Dentin is light yellow or whitish in color with little discoloration and opaque with little translucency or transparency.

Category 2: More than category one but < halfway between categories one and four.

Category 3: Less than category four but > halfway between categories one and four.

Category 4: Significant sclerosis present. Dentin is dark yellow or even discolored (brownish) with a glassy appearance and with significant translucency or transparency evident.

Patients

All patients were informed of the nature and aims of this study and were told they would receive one of the four restorative treatments. Written informed consent was obtained from all patients prior to starting treatment.

Listing of Random Groups of Patients

Restorative materials and procedures used for each group are shown in Table 2. The sclerotic surface of each lesion was gently roughened before conditioning and bonding. All materials were applied according to the manufacturers' instructions except for the light-polymerization method. The groups are as follows:

Group 1 (G1): Total etching (37% phosphoric acid, Vivadent, Schaan, Liechtenstein) was conducted for 20 sec., thoroughly rinsed with water, and gently air-dried with an oil and water-free air stream. The tooth surface was then scrubbed for 20 sec. using Excite adhesive (Vivadent, Schaan, Liechtenstein) and light-cured with an Astralis 10 curing light (Vivadent, Schaan, Liechtenstein) for 20 sec. at 650 mW/cm^2 (Adhes program). The tooth was boxed with a contour strip matrix (Vivadent, Schaan, Liechtenstein) and IntenS composite (Vivadent, Schaan, Liechtenstein) was applied using two increments (cervical and occlusal) according to the manufacturer's instructions. Each increment was light-polymerized using the Astralis 10 curing light for 10 sec. at 1,200 mW/cm^2 (HIP, high intensity program).

Group 2 (G2): The procedure was the same as for G1 except the two increments were light-polymerized with the Astralis 10 curing light for 150 mW/cm^2 at the start, increasing to 650 mWatts/cm^2 for 10 sec., and oscillating up to 1,200 and 650 mW/cm^2 for 10 sec. (Pulse program).

Group 3 (G3): The procedure was the same as for G1 except the composite used was Filtek flow (3M, ESPE, St. Paul, MN, USA) light-polymerized with the Astralis 10 curing light for 40 sec. at 650 mW/cm^2 (Adhes program).

Group 4 (G4): The dentinal surface was scrubbed for 20 sec. using GC conditioner (GC, Japan), rinsed with water, and gently dried in the same conditions. The restoration was placed using FujiII LC capsules (GC, Tokyo, Japan), boxed with a contour strip matrix, then the composite was applied in a single increment and light-polymerized for 40 sec. at 650 mW/cm^2 (Adhes program).

Finishing and Polishing

The unique polishing devices used for all the restorations were the same. Fine (60µm) and very fine (45µm) flame burs (Komet, France) supplemented with a high polisher (pink) (Astropol polishing system, Vivadent, Schaan, Liechtenstein) were used.

Each restoration was evaluated after baseline of 15 days following placement and one year, using the USPHS – Clinical – Photographic index. The clinical criteria were verified for some of the patients using standardized digital photographs (Coolpix 995 Nikon, size 1280x260, 250 ko, Tokyo, Japan). In order to retain maximum accuracy, the clinical and photographic analyses of each tooth's vestibular surface was divided into four sections and scored using the median value.

Statistical Evaluation

Descriptive statistics were used to describe the results. The level of significance was $p<0.05$. Cohen's Kappa test was used to measure the

Table 2. Groups ranked according to the materials and light-polymerization methods.

Groups	Adhesive System	Light Polymerization Methods	Composite Materials
G1	Excite (Vivadent, Schaan, Liechtenstein)	HIP program: 10 sec. at 1200 mW/cm^2	IntenS (Vivadent, Schaan, Liechtenstein)
G2	Excite (Vivadent, Schaan, Liechtenstein)	Pulse programme: 150 mW/cm^2 at the start, rising to 650 mW/cm^2 for 10 sec., and oscillating up to 1200 and 650 mW/cm^2 for 10 sec.	IntenS (Vivadent, Schaan, Liechtenstein)
G3	Excite (Vivadent, Schaan, Liechtenstein)	Adhes program: 40 sec. at 650 mW/cm^2	Filtek flow (3M, ESPE, St. Paul, MN, USA)
G4	Dentin conditioner (GC, Tokyo, Japan)	Adhes program: 40 sec. at 650 mW/cm^2	Fuji II LC(GC, Tokyo, Japan)

visual observations between the examiners (Landis). The statistical analysis was conducted using the Kruskall-Wallis test ($p<0.05$) and a Mann-Whitney U modified test with a corrected significance level.

Results

At the beginning of the trial, all 56 restorations were rated to obtain a baseline. No subjects were lost at the one-year examination. No restorations presented secondary caries, and the retention rate in groups G1, G2, G3, and G4 was 85.7% (two losses), 92.8% (one loss), 100%, and 100%, respectively.

All of the bacteriological tests were positive for both tests except for one patient who was only Streptococci mutans-positive and one other who was only lactobacilli-positive. The saliva buffer capacity and saliva secretion was normal for all the patients.

Dentin Sclerosis Criteria

All the cavities were ranked between categories three and four with evident sclerosis.

Sensitivity

The sensitivity decreased between the pre-operative evaluation and the baseline. No difference was observed between the baseline and the one-year examination. A few teeth were still painful after the restoration but had no increase in sensitivity.

Visual and Digital Analysis

In order to simplify the presentation of the results only the criteria which presented statistically significant differences are described.

Overall Results

The total comparison of the results at baseline showed significant differences only with regard to the clinical acceptance criterion ($p= 0.02$, G4). At the one-year examination, the surface quality criterion exhibited a statistically significant difference ($p= 0.016$, G4). Groups with the same letter did not differ (Table 3).

Group-by-Group Results

Statistically significant differences were observed for the following criteria: sensitivity, integrity, marginal edge, clinical acceptance, color, and surface quality. Only groups G2 and G3 showed any reduction in the sensitivity thresholds between the pre-treatment and baseline ($p< 0.001$). No significant improvement was observed between baseline and one year (Tables 4 and 5).

The marginal integrity and edge criteria analyses showed significant differences for G1 and G4 ($p<0.02$). The surface qualities and color criteria were related to groups G4 (Figures 1, 2, and 3) and G3 ($p<0.006$), and the clinical acceptance criterion exhibited some differences for all the groups (G1, $p<0.02$; G2, $p<0.02$; G3, $p<0.023$; G4, $p<0.01$).

Digital Mode Results

Significant differences were exhibited only in the porosity criteria in group G4 ($p<0.0001$). Differences relating to marginal edge, clinical acceptance, and marginal coloring were apparent in groups G1, G2, and G4.

Visual Mode Versus Digital Mode

The comparison of the two observation modes exhibited differences between the examinations at

Table 3. Visual and digital observations. Overall results. (Groups with the same letter did not differ statistically p = 0.05.)

Visual Analysis Groups	Median Value		Digital Analysis Groups	Median Value	
	Baseline (15 Days Later)	1 Year		Baseline	1 Year
Criteria	Clinical Acceptance	Surface Quality	Criteria	Clinical Acceptance	Porosity
G1	0_a	0_a	G1	0_a	0_a
G2	0_a	0_a	G2	0_a	0_a
G3	0_a	0_a	G3	0_b	0_a
G4	1_b	2_b	G4	1_b	1_b
p	0.02	0.016	p	0.012	0.0001

Table 4. Visual observation. Clinical criteria showing significant statistical differences.

Criteria	Groups	Period	Scores	P
Sensitivity	G2, G3 G1, G2, G3, G4	Pre-op – Baseline Baseline – one year	(2; 0); (6.5; 3)	p<0.0001 NS
Marginal Integrity	G1,G4	15 days – one year	(0; 0.5); (0; 0.5)	p<0.02; p<0.027
Surface Quality	G4	Baseline – One year	(0; 2)	p<0.0065
Color Match	G3	Baseline – One year	(0; 0)	p<0.034
Clinical Acceptance	G1, G2, G3, G4	Baseline – One year	(0; 2); (0; 2); (0; 1);(1; 2)	p<0.02; p: 0.02; p<0.025 p: 0.013
Marginal Edge	G1	Baseline – One year	(0; 0.25)	p<0.03

Table 5. Visual, digital results and their comparison for groups G1-G2-G3-G4.

Visual Analysis	Baseline	1 Year	p (groups)
Marginal Edge	0	0.25	0.03 (G1)
Marginal Integrity	0 0	0.5 0.5	0.02 (G1) 0.027 (G4)
Clinical Acceptance	0 0 0 1	2 2 1 2	0.016 (G1) 0.02 (G2) 0.025 (G3) 0.0013 (G4)
Surface Quality	0	1	0.006 (G4)
Color Match	0	0	0.034 (G3)
Digital Analysis	**Baseline**	**1 Year**	**p (groups)**
Clinical Acceptance	1 0 1	2 2 2	0.006 (G1) 0.0035 (G2) 0.009 (G4)
Marginal Edge	0	1	0.01 (G1)
Marginal Coloration	0 0	0.5 0	0.02 (G1) 0.04 (G2)
Visual versus Digital Analysis	**Baseline**	**1 year**	**p (groups)**
Marginal Edge	(0-0.5)	NS	0.038 (G1) (G4)
Clinical Acceptance	(0-1)	NS	0.02 (G3)

Figure 1. Non carious cervical lesion before treatment on teeth: 33, 34, and 35. Subject without his dentures.

Figure 2. Baseline post operative (15 days later) observation on teeth: 33, 34, and 35. (Restored with Fuji II LC)

Figure 3. One-year old post operative observation on teeth: 33, 34, and 35. (Restored with Fuji II LC)

baseline and at one year. At baseline, the results observed with the digital mode sharply differed in terms of clinical acceptance for groups G1 and G3 and for marginal edge for groups G1 and G4.

Discussion

Analysis of Cofactors

A number of previous studies noting multifactor etiologies[1,4] for non-carious cervical lesions have not provided a good clinical understanding of the phenomenon. In this study various cofactors were analyzed and are listed in Table 6. Patients suffering from bruxism, poor hygiene, and pathological occlusal interference were excluded from this study. The values of the various cofactors confirmed the relative homogeneity of the four groups in terms of dental mobility, saliva pH, size of lesions, number of wear facets, and occlusal contacts. The number of teeth with cavities filled except in the cervical area and the number of teeth with caries except in the cervical area were recorded to determine if our results could be influenced by the residual mechanical properties of the teeth rather than simply determining the classic DMFT (decayed, missing, filled teeth) index. In this particular case, it did not seem to interfere with the results. The effects of not using a split-mouth study design were balanced by the homogeneity of the different cofactors recorded. Furthermore, as the recorded surface of each tooth was divided into four parts, providing a median value for the entire surface, the accuracy of our results increased. All cofactors offered an opportunity to perform an accurate analysis of the different results. Non-carious cervical lesions, extrinsic and intrinsic erosion, and evidence of exogenous and endogenous acids have previously been mentioned as cofactors, especially with teenagers.[6,20] In the present study the median regurgitation or gastric reflux and soft drink values were similar or equal to zero, and the average age of the subjects was approximately 50 years. The characteristics of the non-carious cervical lesion in this study were similar to those evaluated by Aw et al.[21] in terms of tooth location, class occlusion, mobility, depth, and width dimensions and shape (roughly right-angled).

Marginal Integrity, Edge, and Coloration

It was easier to assess the quality of the margins 15 days following insertion (baseline) during a controlled clinical step. Several fillings in all groups showed excesses at the margins at this point in time. This is likely due to the unique polishing step performed at the completion of each restoration during this clinical study. Such a step is routinely performed in private practice in France which can probably be attributed to the fact no additional fee can be charged 15 days later for re-polishing a restoration in the French dental health insurance system.

Table 6. Scores for the various clinical factors.

Groups	G1	G2	G3	G4
Number of teeth with cavities filled except in the cervical area	0	2	0	1
Number of teeth with caries except in the cervical area	2	0	0	0
Median mobility value	1	1	0	0
Median number of times teeth cleaned per day	3	3	2	3
Median lesion depth	2	2	1.75	2
Median pH value	7	6.9	7.4	7.4
Median wax weight (grams)	0.004	0.003	0.004	0.004
Median number of working contacts	1	1	0.5	0.5
Median number of non-working contacts	0	0	0	0
Median wear facets	0	1	1	1
Regurgitation	0	0	0	0
Soft drinks per day	0	0	0	0
No difference between the four groups in terms of the saliva test.				

In visual mode the marginal integrity and edge criteria was related to group G1 (hard-cured method) and only the marginal edge criterion in the digital mode. The comparison of the digital and visual modes confirmed the observations made of group G1. The difference between groups G1 and G2 could be related to the differences in polymerization methods and a reduction in stress as a result of using soft-start polymerization.[16] The shrinkage of the IntenS composite seemed to be reduced by using a delayed irradiation method (G2).

As for the resin-modified glass ionomer, the results were similar to other published studies showing better results for the composite (G2) than the resin-modified glass ionomer in relation to the criteria assessed.[10,22-24]

Sensitivity

The reduction in sensitivity was immediate and did not change between the baseline and one year examinations. It is important to note patients who experienced only slight improvements after treatment were still sensitive to air blast tests one year later. These results differed from those obtained by Powell et al.18 who showed using glass ionomer and composite resin restorations along with a dentin bonding agent significantly reduced sensitivity.

Retention

The retention rates of the restorative materials used in this study were high after one year and were similar to previous studies using similar restoration materials.[10,12,23,24] Even the medium value (wax-weighting technique and lesion depth) were similar for groups G1 and G2. The restorative procedure failed in two cases when the cavity was very small (wax weighing around 0.001g), saucer-shaped, and if the rating on the dentin sclerosis scale was four with a very glossy appearance.[19] Dentists have a responsibility to familiarize themselves with these issues and to inform patients of the benefits in restoring such small deficient areas.[25]

For group G3 (Filtek flow), the retention rate was 100% which is probably due to physical properties allowing the material to flex with the tooth rather than debond during cervical flexure.[26] This factor generally contributed to the good retention rates observed with other materials, although contrasting results have been shown in the literature.[27]

The Fuji II LC possessed two adhesion mechanisms: an auto-adhesive capacity, forming ionic bonds between the carboxyl groups of the polyalkenoic acid and the hydroxyapatite, and micromechanical interlocking of the polymer.[27]

These two adhesion mechanisms with cofactor values similar to group G3 may have contributed to the high retention rate. Another explanation could be the resin-modified glass ionomer undergoes less stress and gap formation from thermal expansion and contraction.[28]

Polymerization Methods

No significant difference was observed between the polymerization methods which were close to those achieved by Brackett et al.[10] even when using pulsed soft-start polymerization. Brackett et al.[10] evaluated the clinical performance of a self-etching adhesive for resin composites over a period of one year and found the adhesive performance to be poor with a 35% overall loss of restorations. This is much higher than in the present study. Nevertheless, the results of the G1 group using a hard-cure device are closely related to the marginal edge and marginal integrity criteria which did not affect the G2 group using the soft-start polymerization method.

Surface Quality and Color Match

The resin-modified glass ionomer had significantly lower surface quality than either the micro-hydrid or flow composites regardless of the curing method used. The surface of the resin-modified glass ionomer was rougher than the other groups as long as the polishing steps were conducted at the end of the restoration without any post-operative polishing (15 days later) and no finishing glaze was applied to the surface. These results have been found in a number of studies comparing resin-modified glass ionomer and composite biomaterials[9,10,29] and their relationship between external color change and surface texture. Despite similar initial surface texture between the four groups the surface roughness of the resin-modified glass ionomer increased to a much greater extent as a result of daily toothbrush abrasion.[27] The primary criterion responsible for increasing the negative surface quality appearance was the increase of surface porosity in the restoration. No difference was observed in the color except for group G3. However, the median value for group G3 was zero. The color match may be related to the surface porosity, which might have changed the color of the restoration by incorporation of food colorants into the surface.

Clinical Acceptance

This important criterion requires objective and subjective observations during the dental restoration clinical examination. All of the evaluations were conducted blind by two trained technicians. This criterion is the most important because it takes into account all the other criteria and determines whether there is any need to preserve, repair, or change the restoration. In the visual mode the four groups were affected by this criterion with score values of two, which means the restorative treatment should be corrected. In the digital mode only the flowable material group avoided this criterion. There was no significant difference for clinical acceptance between the two observation modes. This suggests visual observation is sufficient for this criterion. The unique polishing step following restorative treatment appeared to be one of the clinical decisive factors. All of the clinical imperfections (underfill or overflow) were actually only visible at baseline.

Visual and Digital Observation

The comparison of the two observation modes, visual and digital, showed significant differences for the criteria: clinical acceptance and marginal edge at baseline with groups G1, G3, and G4 being affected. The increased observation (times two or three) of the images in digital mode confirmed the results of the visual mode between these groups at the beginning of the observation but failed to show any differences at one year. This suggests it was difficult to assess the restorative treatment as a whole on the basis of an image which in most cases took place within a one to two week post-operative time interval. Digital mode actually allowed the images to be filed and the observation of the visible specific defects to be consolidated in visual mode. In addition, the color criterion cannot be checked in digital mode. The lack of difference between the two observation modes at one year and the increase in working time when using the digital observation mode reinforced the first observation mode which could be improved using magnification.[30]

Conclusions

1. The resin-modified glass ionomer was the easiest to use. It required only one increment with a high retention rate but failed in terms of surface quality (visual mode) and porosity (digital mode) compared to the other groups.
2. Overall results showed no statistically significant difference between groups G1 (hard-cured) and G2 (soft-cured). However, group G1 was affected by the marginal edge and integrity criteria with a significant result at the one-year examination.
3. The digital mode confirmed the results of the visual mode at the beginning of the observations but failed to show any differences at the one-year evaluation. The lack of difference between the two observation modes at one year and the increase in working time when using the digital observation mode reinforced the visual findings. The visual mode could be certainly improved using magnification.
4. The color criterion cannot be checked in digital mode. The restoration loss was also affected by the small size of the cavity.[31]

5. The reduction in sensitivity was restricted to the first observations (preoperative versus baseline).
6. An added polishing sequence 15 days later seemed to be a useful clinical step.

The use of Filtek Flow or conventional composites polymerized with a soft start method seemed to be the more effective techniques found in this clinical study at one year. This is especially true if esthetic conditions and the use of an easy technique such as the modified glass-ionomer were required.

References

1. Borcic J, Anic I, Urek MM, Ferreri S. The prevalence of non-carious cervical lesions in permanent dentition. J Oral Rehabil 2004; 31: 117-23.
2. Lussi A. Dental erosion clinical diagnosis and case history. Eur J Oral Sci 1996; 104: 191-196.
3. Lussi A, Schaffner M. Progression of and risk factors for dental erosion and wedge-shaped defects over a 6-years period. Caries Res 2000; 34: 182-187.
4. Osborne-Smith KL, Burke FJ, Wilson NH. The aetiology of the non-carious cervical lesion. Int Dent J. 1999; 49: 139-43.
5. Rees JS, Jagger DC. Abfraction lesions: myth or reality? J Esthet Restor Dent. 2003; 15: 259-60.
6. Arnadottir IB, Saemundsson SR, Holbrook WP. Dental erosion in Icelandic teenagers in relation to dietary and lifestyle factors. Acta Odontol Scand 2003; 61: 25-8.
7. Lambrechts P, Van Meerbeek B, Perdigao J, Braem M, Vanherle G. Restorative therapy for erosive lesions. Eur J Oral Sci 1996; 104:229-240.
8. Mjör IA. Clinical management and tissue changes associated with wear and trauma. Pulp-Dentin biology in restorative dentistry. Quintessence Publishing Co., Inc. 2002. Chap 5; 77-94.
9. Abdalla AL, Alhadainy HA. Clinical evaluation of hydride ionomer restoratives in class V abrasion lesions: Two-year results. Quintessence Int 1997; 28: 255-258.
10. Brackett WW, Dib A, Brackett MG, Reyes AA, Estrada BE. Two-year clinical performance of Class V resin-modified glass-ionomer and resin composite restorations. Oper Dent. 2003; 28: 477-81.
11. Ermis RB. Two-year clinical evaluation of four polyacid-modified resin composites and a resin-modified glass-ionomer cement in Class V lesions. Quintessence Int. 2002; 33: 542-8.
12. Ozgunaltay G, Onen A. Three-year clinical evaluation of a resin modified glass-ionomer cement and a composite resin in non-carious class V lesions. J Oral Rehabil. 2002; 29: 1037-41.
13. Young WG, Khan F. Sites of dental erosion are saliva-dependent. J Oral Rehabil. 2002; 29: 35-43.

14. Pintado MR, Delong R, Ko CC, Sakaguchi RL, Douglas WH. Correlation of noncarious cervical lesion size and occlusal wear in a single adult over a 14-year time span. J Prosthet Dent. 2000; 84: 436-43.
15. Whitehead SA, Wilson NH, Watts DC. Development of noncarious cervical notch lesions in vitro. J Esthet Dent 2000; 12: 57Aw TC, Lepe X, Johnson GH, Mancl L. Characteristics of non-carious cervical lesions: a clinical investigation. J Am Dent Assoc 2002; 133: 725-733.
16. Sakaguchi RL, Berge HX. Reduced light energy density decreases post-gel contraction while maintaining degree of conversion in composites. J Dent 1998; 26: 695-700.
17. Gaengler P, Hoyer I, Montag R. Clinical Evaluation of posterior composite restoration: The 10-year report. J Adhesive Dent 2001; 13: 185-194.
18. Powell LV, Gordon GE, Johnson GH. Sensitivity restored of Class V abrasion/erosion lesions: J Am Dent Assoc 1990; 121: 694-6.
19. Swift Jr EJ, Perdigao J, Heymann HO, Wilder Jr AD, Bayne SC, May Jr KN, Sturdevant JR, Roberson TM. Eighteen-month clinical evaluation of a filled and unfilled dentin adhesive. J Dent 2001; 29: 1-6.
20. Imfeld T. dental erosion. Definition, classification and links. Eur J oral Sci1996; 104 : 151-155.
21. Aw TC, Lepe X, Johnson GH, Mancl L. Characteristics of non-carious cervical lesions: a clinical investigation. J Am Dent Assoc 2002; 133: 725-733.
22. Loguercio AD, Reis A, Barbosa AN, Roulet JF. Five-year double-blind randomised clinical evaluation of a resin-modified glassionomer and a polyacid-modified resin in non-carious cervical lesions. J Adhes Dent 2003; 5: 323-332.
23. Folwaczny M, Loher C, Mehl A, Kunzelmann KH, Hickel R. Class V lesions restored with four different tooth-coloured materials-3 year results. Clin Oral Invest 2001; 5: 31-39.
24. Folwaczny M, Loher C, Mehl A, Kunzelmann KH, Hinkel R. Tooth-colored filling materials for the restoration of cervical lesions: a 24-month follow-up study. Oper Dent 2000; 25: 251-258.
25. Grippo JO. Noncarious cervical lesions: the decision to ignore or restore. J Esthet Dent 1992; 4: 55-64.
26. Peumans M, Van Meerbeek B, Lambrechts P, Vanherle G. Two-year clinical effectiveness of a resin-modified glass-ionomer adhesive. Am J Dent. 2003; 16: 363-8.
27. Gladys S, Van Meerbeek B, Braem MJ, Lambrechts P, Van-Herle G. Comparative physico-mechanical characterisation of new hydride restorative materials with conventional glass-ionomer and resin composite restorative materials. J Dent Res 1997; 76: 883-894.
28. Kaplan I, Mincer HH, Harris EF, Clyod JS. Microleakage of composite resin and glass ionomer cement restorations in retentive and non-retentive cervical cavity preparations. J Prothet Dent 1992, 68: 616-623.
29. Neo J, Chew CL, Yap A, Sidhu S. Clinical evaluation of tooth-colored materials in cervical lesions. Am J Dent 1996; 9:15-8.
30. Christensen GJ. Magnification in dentistry: useful tool or another gimmick?. J Am Dent Assoc 2003; 134: 1647-50.
31. Lussi A, Jeaggi T, Schaffner M. Preventive and minimally invasive treatment of erosions. Oral Health Prev Dent 2004; 2: supplement 1: 321-325.

About the Authors

Stephen Koubi, DDS

Dr. Koubi is an Assistant Professor in the Department of Operative Dentistry of the Faculty of Dentistry at the University of the Mediterranean in Marseille, France. His major fields of interests are composite restorations, dental adhesive systems, and prosthetic dentistry.

Anne Raskin, DDS, PhD

Dr. Raskin is an Assistant Professor in the Department of Dental Biomaterials of the Faculty of Dentistry at the University of the Mediterranean in Marseille, France. Her research interests include: microleakage, bond strength, resin composites, dentin bonding, biostatistics, and clinical trials.

Frédéric Bukiet, DDS

Dr. Bukiet is an Associate Professor in the Department of Operative Dentistry of the Faculty of Dentistry at the University of the Mediterranean in Marseille, France. His major fields of interests are endodontic retreatment and restoration of endodontically treated teeth.

Christian Pignoly, DDS

Dr. Pignoly is an Associate Professor in the Department of Operative Dentistry of the Faculty of Dentistry at the University of the Mediterranean in Marseille, France. His major field of interests is in esthetic dentistry.

Edwige Toca, DDS

Dr. Toca is a former Assistant Professor in the Department of Operative Dentistry of the Faculty of Dentistry at the University of the Mediterranean in Marseille, France. Her major fields of interests are composite restorations and esthetic dentistry.

Hervé Tassery, DDS, PhD

Dr. Tassery is an Associate Professor in the Department of Operative Dentistry of the Faculty of Dentistry at the University of Mediterranean in Marseille, France. His major fields of interests are composite restorations, dental adhesive systems, clinical research, and minimally invasive dentistry.

e-mail: tassery.herve@wanadoo.fr

Acknowledgements

The project was supported by Assistance Publique, Hôpitaux de Marseille (APHM) and approved by the Marseilles, France ethics committee (CCPPRB: Comité Consultatif de la Protection des Personnes et de la Recherche Biomédicale).

The authors would like to thank San Francisco Edit (www.sfedit.net) for their assistance in editing this manuscript.