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Two-Year Clinical Performance of a Low-Shrinkage Composite in Posterior Restorations

B Baracco • J Perdigão • E Cabrera
L Ceballos

Clinical Relevance

Clinical performance of the Filtek Silorane Restorative System was similar to that of methacrylate-based restorative systems used in this study after two years of clinical use. Teeth restored with Adper Scotchbond SE + Filtek Z250 showed a trend toward higher marginal staining.

SUMMARY

Objectives: **The aim of this study was to compare the two-year clinical performance of three restorative systems in posterior restorations, which included a low-shrinkage composite and both etch-and-rinse and self-etch adhesive strategies.**

Materials and Methods: **After signing an informed consent, 25 patients received three Class I (occlusal) or Class II restorations performed with one of three restorative systems: Filtek Silorane Restorative System, Adper Scotchbond 1 XT (a two-step etch-and-rinse adhesive) with Filtek Z250, and Adper Scotchbond SE (a two-step self-etch adhesive) with Filtek Z250. All materials were applied following the manufacturer's instructions. Two blind observers evaluated the restorations at three different moments (baseline; and after one and two years) according to the US Public Health Service modified criteria. Kruskal-Wallis test and Mann-Whitney U-test were used to compare the behavior of the restorative systems, while Friedman and Wilcoxon tests were applied to analyze the intra-system data ($p<0.05$).**

Results: **The three restorative systems showed a statistically similar clinical performance at two years. Intra-system comparisons between baseline and two years showed declining marginal adaptation scores in the restorations placed with all systems. In addition, marginal staining and surface roughness scores were**

Bruno Baracco, DDS, Department of Stomatology, Rey Juan Carlos University, Madrid, Spain

Jorge Perdigão, DMD, MS, PhD, Department of Restorative Sciences, University of Minnesota, Minneapolis, MN, USA

Elena Cabrera, DDS, PhD, 3M ESPE Iberia, Professional Service, Madrid, Spain

*Laura Ceballos, DDS, PhD, Department of Stomatology, Rey Juan Carlos University, Madrid, Spain

*Corresponding author: Deparment of Stomatology, Rey Juan Carlos University, Avda. Atenas s/n, Alcorcón, Madrid 18922, Spain; e-mail: laura.ceballos@urjc.es

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lower after two years for the restorations placed with Adper Scotchbond SE + Filtek Z250.

Conclusions: **Although the clinical performance of Filtek Silorane was considered acceptable after two years, no advantage of the silorane-based resin over the methacrylate-based composite was found. Teeth restored with Adper Scotchbond SE showed a tendency for marginal staining, which may compromise the final color of the restorations.**

INTRODUCTION

The polymerization shrinkage of resin composites remains the main drawback of these widely used materials for the restoration of posterior teeth. The volumetric reduction due to polymerization generates stress within the material, at the adhesive interface, and in the tooth structure.[1] The physical mismatch between the shrinkage-prone restorative material and the stiffer tooth structure may result in undesirable clinical situations, such as microleakage, marginal staining, gap formation, postoperative sensitivity, and enamel microcracks or cusp deflection.[2,3]

With this background, several strategies aimed at reducing polymerization shrinkage have been proposed. One of them, the substitution of the most commonly used methacrylate-based monomers[4] for resins with a lower polymerization rate, has been an option since Filtek Silorane was introduced. However, information about the lower polymerization rate of Filtek Silorane is controversial. *In vitro* studies have reported a significantly lower cusp deflection after restoration of MOD preparations with a silorane-based resin composite in comparison to methacrylate-based resins.[5,6] According to the manufacturer's information, volumetric shrinkage is supposed to not exceed 1%. However, recent research has found it to be higher (1.4%)[5,7] and close to the 1.7% total volumetric shrinkage attributed to Filtek Z250, a methacrylate-based resin composite.[7] Additionally, Filtek Silorane did not provide better results than methacrylate-based materials in clinical investigations.[8,9]

Filtek Silorane is part of an integral restorative system that includes a proprietary and specific two-step self-etch adhesive. This adhesive strategy has become increasingly popular, as self-etch adhesives are more user friendly and less technique sensitive and may reduce postoperative sensitivity[10,11] compared to etch-and-rinse adhesives. Nevertheless, their adhesion to enamel, especially those with low acidity (mild self-etch adhesives), is still not comparable to that of etch-and-rinse adhesives, which are considered the "gold standard."[10,12,13]

Clinical trials represent the ultimate test to adequately measure the clinical effectiveness and durability of adhesives and resin composites.[14] This is of paramount relevance, as there is no clinical evidence to back the deleterious effect of polymerization stress on restoration longevity.[15] As mentioned above, few studies have analyzed the clinical performance of the Filtek Silorane Restorative System. The present study was initiated in 2008, and the results of the one-year clinical performance revealed that the application of Filtek Silorane did not provide any advantage over a methacrylate-based resin composite.[9] However, more conclusive outcomes would be expected from a longer period of clinical use. Accordingly, the aim of this study was to compare the two-year clinical performance of three restorative systems in posterior restorations: the low-shrinkage silorane resin composite with its proprietary adhesive and a widely studied methacrylate resin composite, Filtek Z250, used either with a two-step etch-and-rinse adhesive or with a two-step self-etch adhesive. The null hypothesis tested was that there would be no differences in clinical behavior for the three restorative systems after two years.

MATERIALS AND METHODS

Before participating in the study, subjects signed a written informed consent. Both the consent and this research protocol had been previously reviewed and approved by the Ethics Committee of Rey Juan Carlos University.

All patients, with ages ranging from 18 to 60 (average 29.8), required at least three Class I (occlusal) and/or Class II restorations (Table 1). The dental health status of patients was normal in all other respects. Specific exclusion criteria were as follows:

- Fewer than 20 teeth
- History of existing tooth sensitivity
- Periodontal disease (CPITN values higher than 2)
- Extremely poor oral hygiene with evident accumulation of plaque or calculus within the gingival pocket or within the tooth and/or gingival margin
- Bruxism
- Known allergy to resin-based materials or other materials used in this study
- Pregnancy or breast-feeding

Table 1: *Number of Evaluated Restorations by Location (Tooth) and Extension (Class) for Each Restorative System*

Restorative System	Number of Restorations	Tooth		Class		
		Premolars	Molars	I	II	
					MO/OD	MOD
Filtek Silorane Restorative System	25	12	13	12	10	3
Adper Scotchbond 1 XT + Filtek Z250	25	8	17	14	10	1
Adper Scotchbond SE + Filtek Z250	25	13	12	12	12	1
Total (%)	75	33 (44)	42 (56)	38 (50.6)	32 (42.6)	5 (6.6)

- Chronic use of anti-inflammatory, analgesic, and psychotropic drugs

Further, exclusion criteria for the teeth to be restored were as follows:

- Nonvital teeth
- Abutment teeth for fixed or removable prostheses
- Teeth without a normal occlusal relationship with natural dentition or without at least one adjacent tooth contact.

Bitewing radiographs of the teeth to be restored were taken preoperatively, unless the patient had radiographs taken within the previous year. There was an even distribution of the restorations that replaced existing restorations with clinical or radiographic signs of recurrent caries or esthetic failures and restorations that were performed to treat primary caries lesions.

All operative procedures were performed by the same operator (BB). Restorations were placed under local anesthesia with rubber dam isolation. The cavity design was restricted to eliminate carious tissue from primary caries lesions or to remove the restorative material when existing restorations were replaced. Cavities were prepared using diamond burs (Komet-Brasseler, Lemgo, Germany) with no intentional bevels on enamel cavosurface margins. In deep cavities, dentin was covered with a resin-modified glass ionomer cement (Vitrebond, 3M ESPE, St. Paul, MN, USA). An appropriate matrix system (Palodent, Dentsply DeTrey, Konstanz, Germany) and wood wedges were applied to the cervical margins of proximal preparations.

The restorative systems evaluated in this study were the Filtek Silorane Restorative System, Adper Scotchbond 1 XT + Filtek Z250, and Adper Scotchbond SE + Filtek Z250 (Table 2). Initially, the three restorative systems were randomly assigned to each of the three teeth in which restorative treatment was needed, regardless of the characteristics of the tooth and restoration class. However, interference in the randomization procedure within patients was occasionally carried out with the purpose of equally distributing materials into some important variables (tooth type and position, restoration class and size) in such a way that the influence of those factors was minimized.[16] All adhesive systems were applied according to manufacturer's instructions (Table 2). Resin composites were placed in 2-mm increments using an incremental layering technique. Each increment was light cured for 20 seconds using a LED Demetron I polymerization unit (Kerr, Orange, CA, USA) with a minimum light output of 550 mW/cm^2.

After polymerization, coarse finishing was accomplished with carbide burs under water cooling and, if needed, with a #12 blade and aluminum oxide disks (Sof-Lex, 3M ESPE). Final finishing of the occlusal surface was accomplished with polishing points (Enhance and PoGo, Dentsply DeTrey).

Clinical Evaluation

All restorations were evaluated after one week (baseline), one year, and two years for the following parameters: color match, retention, marginal adaptation, anatomic form, surface roughness, marginal staining, sensitivity, and secondary caries (Table 3). Pre- and postoperative sensitivity was determined with a dental syringe placed 2 cm from the tooth surface. Two clinicians (LC and EC) evaluated the restorations blindly at each recall using the modified United States Public Health Service criteria as adapted by Wilson and others[17] (Table 3). When disagreements arose during evaluations, the examiners had to reach a consensus. To help with the evaluation of marginal discoloration, intraoral color photographs were collected at baseline and at the recall appointments. Clinical photographs consisted of digital images at 1.3× magnification taken with a Nikon D80 camera with a 105-mm Micro-Nikkor lens (Nikon USA, Melville, NY, USA).

The statistical analyses were carried out with the IBM SPSS 19 (IBM Corporation, Armonk, New York,

Table 2: *Materials Used in the Study (3M ESPE)*

Adhesives (Batch No.)	Composition	Instructions for Use	Type
Silorane System Adhesive (also known as LS System Adhesive or P90 System Adhesive) (Primer: 8AP; Adhesive: 8AK)	Primer: phosphorylated methacrylates, Bis-GMA, HEMA, water, ethanol, silane-treated silica filler, Vitrebond™ copolymer, initiators, stabilizers	Primer: application for 15 seconds with black microbrush, followed by gentle air dispersion and 10 seconds of light curing	Two-step self-etch
	Adhesive: hydrophobic DMA, phosphorylated methacrylates, TEGDMA, silane-treated silica filler, initiators, stabilizers	Adhesive: application with green microbrush followed by gentle air dispersion and 10 seconds of light curing	
Adper Scotchbond 1 XT (also known as Adper Single Bond Plus or Adper Single Bond 2) (318655)	HEMA, Bis-GMA, GDMA, water, ethanol, silane-treated silica nanofiller, photoinitiator	Acid etch: phosphoric acid (Scotchbond™ Etchant, 3M ESPE): 35% (15 seconds); rinse (10 seconds); blot excess water using a cotton pellet or minisponge; do not air-dry	Etch-and-rinse
		Adhesive: apply two to three consecutive coats of adhesive for 15 seconds with gentle agitation using a fully saturated applicator; gently air thin for five seconds to evaporate solvent; light cure for 10 seconds	
Adper Scotchbond SE (also known as Adper SE Plus) (Liquid A: 7AF; Liquid B: 8AL)	Liquid A (colored wetting solution): water, HEMA, surfactant, rose bengal dye	Liquid A: apply to the cavity so that a continuous red-colored layer is obtained on the surface	Two-step self-etch
	Liquid B (Adhesive): UDMA, TEGDMA, TMPTMA, HEMA phosphate and MHP, bonded zirconia nanofiller, initiator system based on camphorquinone	Liquid B: scrub into the entire wetted surface of the bonding area during 20 seconds; red color will disappear quickly, indicating that the etching components have been activated; air-dry thoroughly for 10 seconds; apply second coat to the entire bonding surface; light air application; light cure for 10 seconds	
Resin composites	**Organic matrix**	**Inorganic filler**	
Filtek Silorane (8BH)	3,4-epoxycyclohexylethylcyclopolymethylsiloxane, bis-3,4-epoxycyclohexylethylphenylmethylsilane, yttrium fluoride (15%), camphorquinone, iodum salt, stabilizers, pigments.	Silanized quartz particles: 50% vol, 70% weight	
		Size: 0.1-2 μm	
Filtek Z250 (7LY)	Silane-treated ceramic, bisphenol A polyethylene glycol diether dimethacrylate, UDMA, Bis-GMA, TEGDMA, Water <2%	Quartz and zirconia particles: 60% vol, 78% weight	
		Size: 0.01-3.5 μm (0.6 μm average)	

Abbreviations: UDMA, urethane dimethacrylate; GDMA, glycerol 1,3-dimethacrylate; HEMA, 2-hydroxyethyl methacrylate; Bis-GMA, bisphenol A diglycidyl methacrylate; TEGDMA, triethylene glycol dimethacrylate; TMPTMA, trimethylolpropane trimethacrylate (hydrophobic TMA); MHP, methacrylic phosphates.

USA) for Windows software using the Kruskal-Wallis test and Mann-Whitney nonparametric U-test to compare the behavior of the three restorative systems at baseline, one year, and two years. Friedman and Wilcoxon nonparametric tests were used to compare the data obtained for each restorative system at each evaluation period. The level of confidence was set at $\alpha<0.05$.

RESULTS

A total of 75 restorations were placed in 25 patients. The distribution of the restorations was similar between Class I (38) and Class II (37) cavities (Table 1). All patients attended the one-year recall (100% rate), although it decreased at the two-year assessment (96% rate), as one patient did not return for the recall. The results are summarized in Table 4.

Comparison of the Performance of the Three Restorative Systems at Two Years

All restorative systems resulted in a percentage of Alfa ratings of 100% at two years for the categories of retention, anatomical form, sensitivity, and secondary caries. However, Alfa ratings for color match, surface roughness, and, especially, marginal adaptation decreased for all the restorative systems, although this reduction did not result in statistical

Table 3: *Modified United States Public Health Service Criteria Used*[a]

Criteria	Code	Definition
Color match	Alfa	Restoration matches adjacent tooth structure in color and translucency.
	Bravo	Mismatch is within an acceptable range of tooth color and translucency.
	Charlie	Mismatch is outside the acceptable range.
Retention	Alfa	Full retention.
	Bravo	Partial retention.
	Charlie	Restoration is lost.
Marginal adaptation	Alfa	Restoration closely adapted to the tooth. No crevice visible. No explorer catch at the margins, or there was a catch in one direction.
	Bravo	Explorer catch. No visible evidence of a crevice into which the explorer could penetrate. No dentin or base visible.
	Charlie	Explorer penetrates into a crevice that is of a depth that exposes dentin or base.
Anatomic form	Alfa	Restorations continuous with existing anatomic form.
	Bravo	Restorations discontinuous with existing anatomic form, but missing material not sufficient to expose dentin base.
	Charlie	Sufficient material lost to expose dentin or base.
Surface roughness	Alfa	Surface of restoration is smooth.
	Bravo	Surface of restoration is slightly rough or pitted but can be refinished.
	Charlie	Surface deeply pitted, irregular grooves and cannot be refinished.
	Delta	Surface is fractured or flaking.
Marginal staining	Alfa	No staining along cavosurface margin.
	Bravo	<50% of cavosurface affected by stain (removable, usually localized).
	Charlie	>50% of cavosurface affected by stain.
Sensitivity[b]	Alfa	None.
	Bravo	Mild but bearable.
	Charlie	Uncomfortable, but no replacement is necessary.
	Delta	Painful. Replacement of restoration is necessary.
Secondary caries	Alfa	Absent.
	Bravo	Present.

[a] *Based on Wilson and others.*[17]
[b] *Postoperative sensitivity at baseline was registered one week after the restoration insertion.*

differences. Marginal staining was not significantly different among the three restorative systems, although only 62.5% of the restorations inserted with Adper Scotchbond SE + Filtek Z250 were rated Alfa.

Baseline Versus Two-Year Evaluation for Each Restorative System

Filtek Silorane Restorative System—Marginal adaptation was significantly worse at two years than at baseline, as 7 of 23 restorations were rated Bravo (p=0.01). The deterioration of the marginal integrity was statistically significant at the one-year assessment and remained significant at two years. On the other hand, marginal staining increased in the last 12 months since two more restorations were rated Bravo at two years, which was close to statistical significance (p=0.59). Only one restoration showed a true color modification over time, and two restorations did not match the adjacent tooth structure because of the yellowish and very opaque aspect of the Filtek Silorane resin composite. One restoration showed signs of clinical failure (fracture of the restorative material, exposure of dentin, and presence of secondary caries) after one year of clinical use, being replaced prior to the two-year evaluation.

Adper Scotchbond 1 XT + Filtek Z250—Color match, marginal staining, and surface roughness parameters resulted in worse rankings at two years although with no statistical repercussion. A significant reduction of the marginal adaptation was detected at two years (p=0.04). No Charlie ratings were assigned to this restorative system for any of the criteria. Postoperative sensitivity (slight discomfort associated with cold beverages) was found in one patient during the first week after the restoration was placed but relapsed thereafter.

Adper Scotchbond SE + Filtek Z250—Marginal adaptation (p=0.005), marginal staining (p=0.005),

Table 4: *Number of Evaluated Restorations in Each Criterion for Each Experimental Group*

Criteria	Code	Materials								
		Baseline			One Year			Two Years		
		Filtek Silorane RS	Adper Scotchbond 1 XT + Filtek Z250	Adper Scotchbond SE + Filtek Z250	Filtek Silorane RS	Adper Scotchbond 1 XT + Filtek Z250	Adper Scotchbond SE + Filtek Z250	Filtek Silorane RS	Adper Scotchbond 1 XT + Filtek Z250	Adper Scotchbond SE + Filtek Z250
Color match	Alfa	23	25	23	22	24	22	20	22	21
	Bravo	2	—	2	3	1	1	3	2	1
	Charlie	—	—	—	—	—	2	—	—	2
Retention	Alfa	25	25	25	24	25	25	23	24	24
	Bravo	—	—	—	1	—	—	—	—	—
	Charlie	—	—	—	—	—	—	—	—	—
Marginal adaptation	Alfa	24	25	25	17	21	18	16	20	16
	Bravo	1	—	—	7	4	7	7	4	8
	Charlie	—	—	—	1	—	—	—	—	—
Anatomic form	Alfa	25	25	25	24	25	25	23	24	24
	Bravo	—	—	—	—	—	—	—	—	—
	Charlie	—	—	—	1	—	—	—	—	—
Surface roughness	Alfa	23	24	25	22	22	21	20	20	20
	Bravo	2	1	—	2	3	4	3	4	4
	Charlie	—	—	—	—	—	—	—	—	—
	Delta	—	—	—	1	—	—	—	—	—
Marginal staining	Alfa	25	25	23	23	22	16	19	21	15
	Bravo	—	—	2	1	3	8	3	3	8
	Charlie	—	—	—	1	—	1	1	—	1
	Delta	—	—	—	—	—	—	—	—	—
Sensitivity	Alfa	25	24	24	25	25	25	23	24	24
	Bravo	—	1	1	—	—	—	—	—	—
	Charlie	—	—	—	—	—	—	—	—	—
	Delta	—	—	—	—	—	—	—	—	—
Secondary caries	Alfa	25	25	25	24	25	25	23	24	24
	Bravo	—	—	—	1	—	—	—	—	—

and surface roughness (p=0.046) were significantly worse at two years than at baseline. All these criteria showed the same trend, as the significant differences were detected in the first year of clinical use and remained stable at the two-year assessment.

Additionally, color stability decreased at the two-year assessment, resulting in a near statistically significant difference (p=0.05). This restorative system was the only one receiving one Charlie rating for color match.

One patient experienced postoperative sensitivity after restoration placement, which disappeared gradually after a few days.

DISCUSSION

In the present study, the three restorative systems resulted in statistically similar clinical parameters after two years. However, regarding the intra-system comparisons between the baseline and two years for each restorative system, all exhibited a statistically lower number of Alfa ratings for marginal adaptation after two years.

Marginal adaptation is influenced mainly by the polymerization shrinkage of the resin composite and the adhesive type,[18] so both factors might have influenced the clinical results of this study. Ideally, marginal adaptation, as an exclusive consequence of polymerization shrinkage and resulting stress, should be assessed at baseline because both take place during the placement of the restoration. However, clinical consequences, such as wear and integrity of the adhesive interface, might have also modified the marginal adaptation during the two years of clinical use.

Polymerization shrinkage of resin composites is considered a potentially harmful factor for the integrity of the restoration at the margins and, consequently for clinical success and longevity of direct restorations because of the release of stresses onto the adhesive interface.[19] The dynamics of the transmission of the stress shrinkage are affected by the cavity configuration.[20] High C-factor values are expected to emerge in Class I and II cavities,[20] where the application technique of the resin composite is also a factor that may influence the bonding effectiveness.[21] Class I and class II preparations were selected in the present study because of the specific recommendation of Filtek Silorane Restorative System for posterior restorations. Additionally, an incremental technique was used for all restorations, as it has been demonstrated to benefit bond strength of both methacrylate-based[22,23] and silorane-based resin composites.[21]

The present study did not find any clinical benefit of Filtek Silorane, the resin composite with reduced polymerization shrinkage. The final value of polymerization shrinkage for this resin composite has been recently questioned since it resulted in a very similar volumetric reduction rate compared to that of Filtek Z250.[5,6] Moreover, Filtek Silorane showed higher elastic modulus and polymerization stress values than those of Filtek Z250.[5] These investigations contradict the idea that less shrinkage polymerization contributes to lower polymerization stress values, as would be originally expected,[24] and confirm that reduced shrinkage *per se* guarantees neither the attenuation of stress effects in restored teeth[5] nor the interfacial integrity of the restoration.[7] These *in vitro* data are strongly in line with the findings of previous clinical studies.[15,25]

Regarding the clinical outcomes in the literature of the Filtek Silorane Restorative System, they are still scarce and contradictory. While a recent publication has detected a worse marginal adaptation than that of a methacrylate-based composite (Ceram•X),[8] another research project found satisfactory performance after two years (84% of optimal marginal adaptation).[26] The present study complements a research project in which one-year results found an acceptable clinical performance of Filtek Silorane, although marginal adaptation was not as stable as that of an etch-and-rinse two-step adhesive combined with a methacrylate-based resin composite (Adper Scotchbond 1 XT + Filtek Z250).[9] Analysis of data obtained from the two-year clinical assessment revealed that the advantages of the

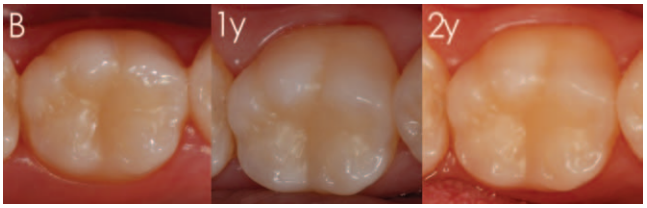

Figure 1. *First mandibular molar. Occlusal restoration with Adper Scotchbond 1 XT and Filtek Z250. This restoration preserved its original aspect after one and two years. No signs of adhesive deterioration were found. B, baseline; 1Y; one-year recall; 2Y, two-year recall.*

Adper Scotchbond 1 XT + Filtek Z250 restorative system measured at one year had disappeared at two years. The basic and most important clinical finding is in agreement with the peer-reviewed literature: the silorane-based resin composite provides adequate clinical performance that does not surpass the behavior of methacrylate-based materials.[8,9,26]

Results from the one-year evaluation were in part explained by the use of different adhesive strategies. In regard to the two-year outcomes, it is noteworthy that the restorations performed with only the etch-and-rinse adhesive obtained the highest number of Alfa ratings for marginal adaptation (Figure 1). Nevertheless, in this case, it did not lead to a statistically better outcome than that achieved with self-etch adhesives, which agrees with previous clinical research in which a similar clinical performance was observed between self-etch and etch-and-rinse adhesives.[27,28] Many of the marginal defects detected in the present study appeared to result from the fracture of thin flashes of resin composite that extended to noninstrumented enamel surfaces adjacent to the cavity margins.

The adhesive system that accompanies Filtek Silorane requires separate light curing of the primer and the bonding resin, thereby establishing the bonding mechanism to hard dental tissues in the first application step, resembling one-step self-etch adhesives. This primer has a relatively high pH (2.7) and contains the Vitrebond copolymer, which has been reported to be able to chemically bond to the calcium within the hydroxyapatite,[29,30,31] as explained by the "adhesion-decalcification" concept.[32] According to this, Mine and others[33] observed a tight superficial interaction and a very slight inter- and intracrystallite demineralization with subsequent resin infiltration when bonded to enamel. In regard to dentin, it has been demonstrated that the Filtek Silorane adhesive system

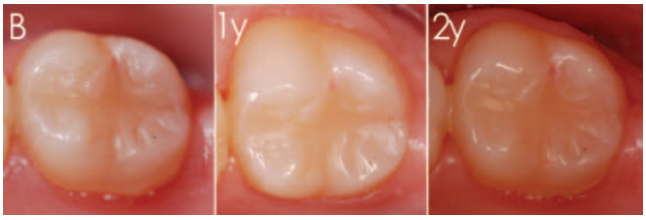

Figure 2. *Second mandibular molar. Occlusal restoration with Adper Scotchbond SE and Filtek Z250. Marginal staining located at the buccal central margin was observed from baseline and remained stable during the following assessments, being rated Bravo (<50% of cavosurface is affected). B, baseline; 1Y; one-year recall; 2Y, two-year recall.*

Figure 3. *First maxillary molar. Occlusal restoration with Filtek Silorane Restorative System. This restoration was rated Bravo for color parameter in all the evaluations because of the poor esthetic characteristics of the composite resin. No signs of adhesive deterioration were found. B, baseline; 1Y; one-year recall; 2Y, two-year recall.*

provides a tight, stable, and water-resistant adhesion to dentin.[31,33]

Besides marginal adaptation, intra-system comparison also detected a deterioration of the surface roughness and marginal staining parameters after two years for the restorations performed with Adper Scotchbond SE + Filtek Z250. Surface roughness should not be different from that recorded with Adper Scotchbond 1 XT + Filtek Z250 since both systems included the same resin composite, which was always applied, finished, and polished in the same way. In fact, the results at two years were exactly the same for both restorative systems, so the statistical repercussion could be ascribed to their different values at baseline.

Meanwhile, marginal discoloration may be considered a clinical sign indicating that a restoration is prone to failure or, at least, that the adhesive interface degrades with time.[34] Although Adper Scotchbond SE is a strong self-etch adhesive (pH = 1),[35] with high etching ability, marginal discoloration and color changes were detected, as it has been previously reported for another strong self-etch adhesive.[34] Adper Scotchbond SE is similar to a one-step self-etch adhesive, as Liquid A is a HEMA-water solution with no etching ability that turns from pink to yellow after the application of Liquid B, containing the acidic monomers. However, this activation may lead to an incomplete conversion of the acidic monomers and their inclusion in a HEMA-rich (with an enhanced susceptibility to hydrolytic degradation) and still pink-colored adhesive interface. This possibility was corroborated by the presence of the characteristic pink shade in most of the stained margins around Adper Scotchbond SE + Filtek Z250 restorations (Figure 2).

High color instability after water immersion has been revealed for a self-etch adhesive (One-Up Bond F) with a very similar color-change mechanism to that of Adper Scotchbond SE.[36] Moreover, it was concluded that discoloration of the adhesive interface may affect the color appearance of the entire restoration,[36] which is highly consistent with what evaluators found in the present study, as all Adper Scotchbond SE + Filtek Z250 restorations that rated Bravo or Charlie for color match showed variable saturation of pink, even at the baseline evaluation (Figure 2).

Regarding Filtek Silorane, the two Bravo ratings for color match at baseline were caused by the poor esthetic characteristics of the silorane resin composite (Figure 3). As mentioned before, this restorative system has been especially designed for restorations in posterior teeth, where the esthetic demand is less critical. Consequently, the manufacturer provides only four shades. The evaluators deemed these restorations too yellow and very opaque, with a very different translucency from that of tooth structure (Figure 3). Both restorations were also rated Bravo in the subsequent follow-up assessments; therefore, only one restoration showed a real color modification over time. These observations derived from the *in vivo* analysis are consistent with *in vitro* research demonstrating low translucency[37] and high color stability of silorane resin composite compared to those of methacrylate-based resin composites.[38]

CONCLUSIONS

The clinical performance of the Filtek Silorane Restorative System was found acceptable after two years. Despite the limitations of this study, the clinical outcomes led to the perception that the Filtek Silorane Restorative System did not provide any detectable advantage for the evaluated criteria compared to the methacrylate-based restorative systems used in this study. Teeth restored with Adper Scotchbond SE + Filtek Z250 showed a trend

toward higher marginal staining, which may compromise the final color of the restorations.

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Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article *except for the following*: Dr Elena Cabrera reports personal interests in 3M ESPE for the following reasons: Dr Cabrera has been affiliated with 3M ESPE Iberia since 1 July 2011. At the time this research project was carried out, this author was affiliated exclusively with Rey Juan Carlos University. This author has not participated in the writing of this manuscript, but she agrees with the contents.

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