Sealing capacity of a photochromatic flowable composite as protective base in nonvital dental bleaching

C. Llena[1,2], J. Amengual[3] & L. Forner[4]

[1]Valencian Health Service; [2]Cardenal Herrera-CEU University; [3]Private Practice, Vinalesa; and [4]Department of Stomatology, University of Valencia, Valencia, Spain

Abstract

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Aim To evaluate microleakage of a flowable composite used as a protective isolating base, applied with different adhesive systems.

Methodology Seventy root-filled teeth were divided into seven groups. A flowable composite base (Tetric Flow Chroma) was used with three adhesive techniques (Syntac, Excite, Excite DCS; in the three cases with and without acid etching) and in a control group without dentine conditioning or adhesive placement. A 30% hydrogen peroxide solution was applied for 24 h in the pulp chambers, followed by the placement of a dye (silver nitrate) for 4 h. Each tooth was sectioned longitudinally, and examined under 4× magnification to assess the tooth/restoration dye leakage following a four-degree scale. Percentage of dye penetration was registered. Statistical analysis was made through the Tukey and Mann–Whitney *U*-tests.

Results Maximum leakage (100% of specimens) was recorded in the control group without an adhesive system. In the groups subjected to acid etching, the percentage of leakage corresponded to Excite DSC (10%), followed by Syntac (20%) and Excite (30%). In the groups in which only an adhesive system was used, 50% of the teeth demonstrated dye leakage. Statistically significant differences in terms of leakage were observed between the control group and the experimental groups ($P < 0.05$). There were no significant differences among the experimental groups, but comparing the leakage percentages obtained between the groups in which the teeth were subjected to prior acid etching, and those in which no etching was carried out, observed differences were significant ($P = 0.04$).

Conclusions There were no significant differences between the adhesive systems in terms of leakage. Acid etching significantly reduced leakage.

Keywords: bleaching, bonding system, cavity base, flowable composite resin, microleakage.

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Introduction

The bleaching of root-filled teeth requires protection of the pulp chamber in order to prevent progression of the bleaching agents through the dentinal tubules towards the cervical periodontal tissues from where such agents can give rise to post-bleaching external cervical root resorption (Fuss *et al.* 1989, Friedman 1997). Although the mechanisms by which this occurs have not been fully elucidated, some authors attribute the phenomenon to localized inflammatory reactions caused by bleaching-mediated oxidative stress (Floyd 1990, Dahlstrom *et al.* 1997), while other investigators (Friedman *et al.* 1988, Madison & Walton 1990, Rotstein 1991, Heller *et al.* 1992, Heithersay *et al.* 1994, Weiger *et al.* 1994, Friedman 1997) consider it to be an immune response against dentine denatured by the action of the bleaching agents (Koulaouzidou *et al.* 1996).

The appropriate placement of intracoronal and/or intra-radicular restorative materials provides an

Correspondence: Carmen Llena, Valencian Health Service, Albuixech n° 8, 2ª, 46021, Valencia, Spain (Tel.: +34963604877; fax: +34963864144; e-mail: llena@uv.es).

effective mechanical barrier of the root canal (Brighton *et al.* 1994). McIsaac & Hoen (1994) proposed that a protective base should always be used to seal the root canal and thus prevent movement of the agents used in internal nonvital bleaching procedures. The isolating protective base should be compatible with restorative materials, should not interact with the dentine surface that is going to be bleached and should not result in tooth discolorations (Amengual *et al.* 2001).

Many materials have been proposed as protective bases, including Cavit (3M Espe, St Paul, MN, USA), zinc oxide-eugenol cements, zinc oxyphosphate cements, glass–ionomers or composite resins. To date, composite resins have offered the best marginal seal in association with various types of restorations (Beznos 2001, Chuang *et al.* 2001, Gladys *et al.* 2001). However, they are tooth coloured which makes it difficult to identify the material and then remove it when required. Consequently, a new composite capable of temporarily changing colour in response to the application of polymerization light, and with a fluid consistency to allow easy adaptation to the dental walls in areas of difficult access has been developed (Tetric Flow Chroma, Vivadent®; Schaan, Liechtenstein).

Syntac Sprint (Vivadent) is an adhesive system composed of hydroxyethyl methacrylate (HEMA), a modified methacrylate of polyacrylic acid and maleic acid, using water as excipient and containing fluorated derivatives. Excite (Vivadent) contains ethanol as a solvent together with HEMA, dimethacrylate, phosphonic acid acrylate and highly dispersed silicon dioxide. Excite DSC (Vivadent) has the same composition as Excite, although with the presence of polymerization chemical initiators contained in the brush. Therefore, this product involves a dual curing system where self-polymerizable initiators are placed in the brush, and light-curable initiators in the bottle liquid producing both auto- and photo-polymerization when mixed. This ensures improved polymerization in areas where light penetration proves difficult. This product also contains a nanoparticle-based filler component.

The present study aimed to assess Tetric Flow Chroma marginal adaptation when used as a pulp chamber sealing base prior to internal bleaching, combined with different adhesive techniques.

Materials and methods

The material used as the cavity base was Tetric Flow Chroma, a flowable composite that contains a photochromatic dye that changes colour to green when exposed to halogen light, even after it has been polymerized. This colour change facilitates identification of the material and is a temporary feature lasting for 4 min after exposure to the light.

Seventy anterior and premolar teeth extracted for periodontal reasons were used. The external surfaces were cleaned, and the teeth were immersed in distilled water until use. The same medium was used to store the specimens in the different phases of the study. In each tooth, root canal treatment was completed using a conventional stepback preparation technique; the canals were filled with a lateral condensation procedure. Gutta-percha was then removed from the pulp chamber and from 2 mm within the canal with a heated instrument, creating room for the cavity base. The specimens were then divided into seven groups of 10 teeth each. Tetric Flow Chroma was applied as a base in all cases but different methods for preparing the dentine were used in each group as shown in Table 1; in the control group (group 1) Tetric Flow Chroma was applied without an adhesive technique; in the other groups the adhesives were applied following the instructions of the manufacturer. A micrometric pipette was then used to place 30% hydrogen peroxide into the pulp chambers for 24 h. After this period, the pulp chambers were rinsed with water and the bleaching solution was replaced with 50% silver nitrate solution for 4 h. The dye was washed out with water, each tooth was cut into two halves, and both were exposed to sunlight for 2 h to promote oxidation of the dye to a black colour. Finally, the sections were examined under 4× magnification to assess the degree of leakage, based on a four-degree scale: 0 = no leakage, 1 = leakage affecting less than half the thickness of the lateral wall of the cavity base, 2 = leakage affecting more than half the wall, and 3 = leakage affecting the floor of the cavity base.

The results obtained were statistically analysed using the statistical package SPSS 11.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were produced. Two-by-two group comparisons were made using the Tukey test, after an analysis of variance for the degree of

Table 1 Distribution of groups

Group 1	Tetric Flow Chroma (TFC)
Group 2	Acid etching + Excite DSC + TFC
Group 3	Excite DSC + TFC
Group 4	Acid etching + Excite + TFC
Group 5	Excite + TFC
Group 6	Acid etching + Syntac Sprint + TFC
Group 7	Syntac Sprint + TFC

leakage. The nonparametric Mann–Whitney *U*-test was used to compare degrees of leakage between those groups in which etching was performed versus those in which etching was not carried out.

Results

In the group where no dentine conditioning or adhesive system were used prior to placement of the base (group 1: positive control), leakage was observed in all teeth with statistically significant differences ($P < 0.05$) from the experimental groups; there were no statistically significant differences among the experimental groups.

In the groups where the adhesive system was placed without acid conditioning (groups 3, 5 and 7) leakage occurred in between 30% and 50% of specimens. In the groups subjected to acid etching before adhesive placement (groups 2, 4 and 6), the least number of teeth with leakage corresponded to group 2 (10%) in which a dual-cure adhesive system was used, followed by group 6 (20%) in which a photocured water-based adhesive system was used (Table 2). Overall 68% of the specimens in which some adhesive was used had no microleakage, and leakage affected less than half the thickness of the wall in 17% of the cases. Significant differences ($P = 0.04$) occurred between the groups in which the teeth were subjected to prior acid etching and those in which no etching was carried out (Table 3).

Table 2 Percentage of leakage by degrees

Groups	No leakage	Leakage <1/2 wall	Leakage ≥1/2 wall	Cavity floor leakage
1	0	4 (40.0)	1 (10.0)	5 (50.0)
2	9 (90.0)	1 (10.0)		
3	5 (50.0)	3 (30.0)	1 (10.0)	1 (10.0)
4	7 (70.0)	1 (10.0)	2 (20.0)	
5	7 (70.0)			3 (30.0)
6	8 (80.0)	1 (10.0)	1 (10.0)	
7	5 (50.0)	4 (40.0)		1 (10.0)
Total	41 (57.1)	14 (21.4)	5 (7.1)	10 (14.3)

Values are given as *n* (%). *n* = number of elements.

Table 3 Comparison of leakage according to acid etching use ($P = 0.04$)

	Etching	No etching	Total
No leakage	24 (80)	17 (56.66)	41 (68.33)
Leakage <1/2 wall	3 (10)	7 (23.33)	10 (16.66)
Leakage ≥1/2 wall	3 (10)	1 (3.33)	4 (6.66)
Cavity floor leakage		5 (16.66)	5 (8.33)
Total	30	30	60

Values are given as *n* (%). *n* = number of elements.

Discussion

Restorative materials in class V cervical cavities are often stressed using leakage models with various criteria to assess dye penetration depth (Chan & Swift 1990). However, leakage around dental materials used as cavity barriers in nonvital bleaching is not routinely evaluated. A four-step scale was used to categorize leakage along with a positive control group.

While it is generally accepted that a cavity base should be placed before performing internal bleaching techniques in root-filled teeth, controversy persists as to which material is best suited for this purpose. Results obtained in the present study suggest that a composite resin could be used as an intracoronal barrier, but its optimal effect will occur after acid etching dentine conditioning. Other materials have been investigated for use as intracoronal barriers. Zinc oxide-eugenol cements, composite and glass–ionomer were found to be ideal for this purpose provided their thickness exceeded 1 mm (Costas & Wong 1991). However, zinc oxide-eugenol is incompatible with composite resins and hydrogen peroxide produces adverse effects upon glass ionomer (Rotstein *et al.* 1992a). These latter authors also investigated the capacity of using an ethylcellulose polymer and an acid methacrylic copolymer for the same purpose. An important reduction in leakage of bleaching peroxide was observed after applying a triple-layer protective base of both products (Rotstein *et al.* 1992b). Another comparative study experimentally evaluated the sealing performance of three materials (Cavit, zinc oxide-eugenol and zinc phosphate) and found an improved response with Cavit and zinc oxide-eugenol compared with zinc phosphate (McInerney & Zillich 1992). A similar study (Hansen & Davis 1992) reported superior barrier efficacy with Cavit versus zinc oxide-eugenol. The efficacy of four materials was analysed, including two cavity bases (zinc oxide-eugenol and IRM), a glass–ionomer (Ketac-Cem) and an amelodentinal bonding agent (Scotchbond multipurpose), yielding a high incidence of leakage with all four materials (Brighton *et al.* 1994).

Heymann (1997) and Swift (1997) experimentally showed the possibility of dissolving cements based on glass–ionomer and/or zinc phosphate when subjected to the action of dental bleaching agents. In contrast, Baldissara *et al.* (1998) evaluated the properties of zinc phosphate and found it to offer adequate performance as an isolating sealing base. Abou *et al.* (1998) in turn conducted a study where bases containing eugenol were found to exert a toxic effect upon cultured cells

with increased deleterious effects upon augmenting the eugenol concentration.

Based on a clinical survey, Hara & Pimenta (1999) proposed the use of light-curable glass–ionomer cements as an intracoronal protective barrier, based on their easy manipulation characteristics and good adhesion to dental tissues. The introduction of the photochromatic material considered in the present study (Tetric Flow Chroma) offers a new alternative cavity base material for internal bleaching (Amengual *et al.* 2001).

A flowable composite resin could be an adequate material for sealing prior to internal dental bleaching because of its intrinsic characteristics and ease of placement. On the contrary, the special property of the material studied, its ability for changing colour when illuminated, allows it to be distinguished easily from the surrounding dental tissues when, for instance, a root canal retreatment is necessary. Optimal sealing capacity of this material was observed when used with a dual-cured adhesive system after a total etching process as a protective isolating base prior to the bleaching of root-filled teeth.

Conclusion

There were no significant differences between the adhesive systems in terms of leakage. Acid etching significantly reduced leakage.

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