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Five-year Clinical Evaluation of 300 Teeth Restored with Porcelain Laminate Veneers Using Total-etch and a Modified Self-etch Adhesive System

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Clinical Relevance

Total-etch (Scotchbond Multi-Purpose Plus) and two-step self-etch (AdheSE) adhesive systems were successful in terms of marginal adaptation, cavosurface discoloration, secondary caries, postoperative sensitivity, satisfaction with restoration shade and gingival tissue response in a five-year follow-up.

SUMMARY

This study evaluated the long-term clinical performance of porcelain laminate veneers luted with hybrid composite in combination with total-etch and self-etch adhesive systems. The study was performed on 30 patients ranging in age between 28 and 54 years. Ten veneers were performed per patient in the maxillary arch. In Group 1, 150 teeth were treated with porcelain veneers, using a total-etch adhesive system (Scotchbond Multi-Purpose Plus, 3M ESPE). In Group 2, 150 teeth were bonded with a self-etch adhesive system (AdheSE, Ivoclar-Vivadent). All the veneers were luted with a light-cured hybrid composite (Z100, 3M ESPE). The patients were recalled after 1, 2 and 5 years. Modified United States Public Health Service (USPHS) criteria were utilized to evaluate the porcelain laminate veneers in terms of marginal adaptation, cavosurface marginal discoloration, secondary caries, postoperative sensitivity, satisfaction with restoration shade and gingival tissue response. Data were analyzed using the Chi-Square test ($p<0.05$). There was no statistically significant difference between the total-etch and self-etch groups in terms of USPHS criteria ($p>0.05$). Porcelain veneers exhibited successful clinical performance with both total-etch and two-step self-etch adhesives at the end of five-years.

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INTRODUCTION

The treatment of defective and discolored anterior dentitions has always created a challenge for dentistry. For many years, the most predictable and durable esthetic

correction of anterior teeth has been achieved by the preparation of full crowns.[1] However, this treatment causes extensive loss of sound tooth substance. Significant progress in bonding capacity to both enamel and dentin has enabled the luting of porcelain veneers to the labial surfaces of teeth.[2-4] The luting of porcelain veneers to minimally invasively prepared teeth requires various treatments of both tooth substrate and the veneer restoration. These treatments include hydrofluoric acid application, silanization and bonding application on the veneer side and acid etching, primer and bonding application on the tooth surface.

Bonding to enamel has been very successful since Buonocore introduced the acid-etch technique.[5] However, the integrity of restorations with dentin margins is still an important research topic. Although minimal preparation limited to enamel is always the aim during veneer preparation, a slight exposure of dentin is often inevitable. Furthermore, in the correction of malpositions, dentin may be exposed in certain regions of the tooth to be veneered.

Recent dentin adhesives use one of two strategies to interact with the dentin smear layer: the total-etch technique and the self-etch technique.[6] Until the development of self-etch adhesive systems, total-etch adhesives were utilized in restorative procedures. Similarly, total-etch systems were used for the luting of porcelain laminate veneers. Total-etch adhesive systems rely on the application of phosphoric acid to enamel and dentin before applying the primer and adhesive either separately or in combination. Etching enamel is efficient in demineralizing the inorganic enamel surface, creating microporosities for a patent and mechanical bond.[7-8] On the other hand, the acid-etching application on dentin removes the smear layer and opens up the dentinal tubules.[8-9] However, total-etch systems have the disadvantage of being technically sensitive to such factors as excessive etching, excessive air drying after etching and overwetting of the dentin.[10] Excessive etching can also lead to denaturing of the collagen fibers, compromising the hybrid layer integrity, especially when monomers do not completely penetrate or do not completely polymerize. Demineralized dentin may not be completely impregnated by resin.[11] This zone could be susceptible to continuous degradation. Also, there is a risk of collapse of collagen during air drying after etching.[12] These applications may increase the movement of dentinal fluids. This movement is interpreted as pain by sensory fibers at the pulp wall. This is defined as hyper- or postoperative sensitivity.[13-14]

With the introduction of self-etch adhesive systems, three-step applications were reduced to two steps by not requiring a separate acid etching step.[8] These adhesives are composed of an aqueous mixture of acidic functional monomers, generally phosphoric acid esters, with a pH relatively higher than that of phosphoric acid etching gels.[7] Acidic monomers partially dissolve the hydroxyapatite on the enamel surface. Self-etch adhesives do not fully remove the smear layer from dentin, leading to less post-operative sensitivity.[13] Monomers incorporate the smear layer into the demineralized dentin substrate. Self-etch systems also facilitate complete infiltration and penetration of the resin monomers into the collagen network of demineralized dentin, purportedly enhancing marginal integrity.[13-14] Furthermore, controlling the moistness of the substrate is not required in self-etching adhesive procedures.

A review of the dental literature reveals that there are a wide variety of studies that aim to compare self-etch and total-etch adhesive systems in composite restorations.[15-18] However, no study has been conducted to date that compares the clinical performance of self-etch and total-etch adhesives in the luting procedure of porcelain laminate veneers. Therefore, the purpose of this prospective comparative cohort study was to assess the long-term clinical performance of porcelain laminate veneers luted with hybrid composite in combination with total-etch and modified self-etch adhesive systems.

METHODS AND MATERIALS

Selection Criteria of Patients

The current study was performed on 30 patients (totally 300 veneers) ranging in age between 28 and 54 years. Fifteen patients (10 veneers per patient in the maxillary arch, totaling 150 veneers) were randomly selected for Group 1 (treated with porcelain veneers using a total-etch adhesive system [Scotchbond Multi-Purpose Plus, 3M ESPE, St Paul, MN, USA]); the other 15 patients (10 veneers per patient in the maxillary arch, totaling 150 veneers) took part in Group 2 (veneers bonded with a self-etch adhesive system [AdheSE, Ivoclar-Vivadent, Schaan, Liechtenstein]). Subjects included in the study suffered from diastemia, misproportioned teeth, misaligned anterior teeth, discolored teeth and eroded or abraded teeth. Patients with extensive loss of tooth structure, excessive crowding of the teeth, parafunctional habits, poor oral hygiene, periodontal problems and smokers were excluded.

Preparation Procedure

During preparation of the teeth, the labial enamel was reduced approximately 0.75 mm. Butt-joint preparation was performed at the incisal edge. Cervical preparation was finished supragingivally.

After preparation, impressions were taken utilizing elastomeric impression materials (AFFINIS, Coltène Whaledent, Cuyahoga Falls, OH, USA) in a stock tray. Gingival retraction was contra-indicated, because the free gingival margin was used as an important landmark to locate the proper extension of the porcelain

laminate veneer margins. Therefore, a retraction cord was not used for the gingival tissues during the impression procedure. After spot-etch application for 10 seconds, light-cured resin composite was used as temporary cover without any bonding agent application. Shade selection for porcelain laminate veneer was performed using a standard Vita porcelain shade guide.[19]

Cementation Procedure

The veneers (IPS-Empress 2, Ivoclar-Vivadent) were fabricated by a laboratory, which returned the veneers grit-blasted with 50 µm aluminum oxide. Before try-in, a thorough prophylaxis was conducted using pumice mixed with water and applied to the tooth surface by way of a rubber cup. Isolation was performed using cotton wool rolls and a saliva ejector. The restorations were tried-in to check their fit and color matching. The porcelain veneers were tried-in dry without any try-in cement. The color of the hybrid composite used for luting was chosen according to the cervical dentinal color by using a Vita scale.

The inner sides of the porcelain veneers were etched with 9.6% hydrofluoric acid (Pulpdent Corporation, Watertown, MA, USA) for one minute at chairside. After rinsing and drying the hydrofluoric acid, silane coupling agent (Monobond-S, Ivoclar-Vivadent) was applied for 60 seconds and dried. The bonding agent was applied to the inner surface without any curing procedure. A resin composite (Z100, 3M ESPE) was placed as a thin layer to the inner side of the porcelain veneer and covered with a black box to prevent the adverse effects of light. The restorative materials utilized in the current study are presented in Table 1. The groups included in this study are as follows:

Group 1: One-hundred and fifty porcelain veneers were bonded with a total-etch adhesive system (Scotchbond Multi-Purpose Plus, 3M ESPE).

Thirty-five percent phosphoric acid agent was applied to enamel for 30 seconds and to dentin for 15 seconds. The surfaces were rinsed carefully and gently dried to leave a slightly moist surface for wet bonding. Scotchbond Multi-Purpose Plus primer was applied to enamel and dentin surfaces for five seconds and gently dried. Scotchbond Multi-Purpose Plus Adhesive was applied to enamel, dentin and porcelain inner sides without any light curing. Prepared porcelain veneers were placed with a thin layer of resin composite to tooth surfaces. Dental floss was used to remove excess luting material extruded from the veneers' margins. The veneers were light cured with a halogen light curing unit (PolyLUX II, KaVo, Biberach, Germany) at an intensity of 600 mW/cm^2 for 40 seconds from the labial, palatal and margin areas, respectively. Finishing and polishing procedures were performed using Komet superfine diamond burs (Gebr, Brasseler, Lemgo, Germany) and polishing strips (Gebr). Finally, the occlusal contacts were checked.

Group 2: Thirty-five percent phosphoric acid agent was applied at the enamel cavosurface margins for 15 seconds. (Miguez and others[20] and Erhardt and others[21] have reported that 15 seconds acid etching prior to application of the self-etching primer produced higher bond strengths to enamel than self-etching priming only. Therefore, acid etching was performed for 15 seconds in the current clinical study.) After rinsing and drying, self-etching primer (AdheSE, Ivoclar-Vivadent) was applied to tooth surfaces, including enamel and

Table 1: *The Properties of the Restorative Materials Used in This Study*

Products	Type	Composition	Application Procedure	Manufacturer
Scotchbond Multi-Purpose Plus	total-etch adhesive system	**Primer**: HEMA **Adhesive Resin**: HEMA, Bis-GMA	Apply twice, gently agitate for 20 seconds, thoroughly air dry for at least 5 seconds, light cure for 20 seconds	3M ESPE, St Paul MN, USA
AdheSE	two-step self-etch adhesive	**Primer**: Mixture of dimethacrylates, phosphoric acid acrylate, water, initiators and stabilizers **Bonding**: Mixture of dimethacrylates, HEMA, highly dispersed silicon dioxide, initiators and stabilizers	Apply a single layer of AdheSE primer and brush the material for 30 seconds, remove excess material with a strong stream of air. Apply AdheSE bonding, gently air dry, light cure for 10 seconds	Ivoclar-Vivadent Schaan, Liechtenstein ,
Z100	hybrid composite	**Matrix**: Bis-GMA, TEGDMA **Filler**: Zirconia/silica, filler size: 0.01-3.5 µm, filler content % by volume: 66	Light cure for 40 seconds	3M ESPE St Paul MN, USA

HEMA: 2-hydroxyethyl methacrylate
Bis-GMA: bis-phenol A diglycidylmethacrylate
UDMA: urethane dimethacrylate
TEGDMA: triethyleneglycol dimethacrylate
Bis-EMA: bis-phenol A polyethoxylated dimethacrylate
DMAs: dimethacrylates

Table 2: *The Criteria Applied to Evaluate the Restorations*

Characteristics	Rating			
	Alpha (A)	**Bravo (B)**	**Charlie (C)**	**Delta (D)**
Marginal Adaptation	No visible evidence of a crevice along the margin that the explorer will penetrate	Visible evidence of a crevice along the margin that the explorer will penetrate	Explorer penetrates crevice, reaching dentin, or base is exposed	Restoration is mobile, fractured or missing
Cavosurface Marginal Discoloration	No discoloration anywhere on the margin between the restoration and the tooth structure	Discoloration present, but has not penetrated along the margin in a pulpal direction	Discoloration penetrated along the margin in a pulpal direction	N/A
Secondary Caries	No caries as evidenced by softness, opacity or demineralization at the margin of the restoration	Evidence of caries at margin of the restoration	N/A	N/A
Postoperative Sensitivity	No postoperative sensitivity	Postoperative sensitivity	N/A	N/A
Satisfaction with Restoration Shade	Both patient and dentist are very satisfied	Patient or dentist is satisfied	The color was acceptable	N/A
Gingival Tissue Response	Healthy and no tooth calculus formed	Calculus or gingivitis detected	Gingival tissue swollen or bleeding	Pocketing present

N/A: not applicable

dentin, for 30 seconds. After removing the primer with a strong stream of air, AdheSE bonding agent was applied and gently dried for 1-2 seconds to the tooth surface and porcelain inner side. A hybrid composite (Z100, 3M ESPE) was used as luting material. All other clinical steps (cleaning, curing, finishing and polishing) were performed as described in Group 1.

Patients were recalled one week after placement of the veneers in order to observe the oral hygiene and gingival response and to check for margin cement excess. Any necessary adjustments or additional finishing and polishing were performed as required. This recall was set as the baseline.

One experienced investigator undertook the recall evaluations at the baseline and at one-year, two-year and five-year recalls. The restorations were assessed using a mirror and explorer according to the modified United States Public Health Service (USPHS) criteria[22] that included marginal adaptation, cavosurface marginal discoloration, secondary caries, postoperative sensitivity, satisfaction with restoration shade and gingival tissue response. The criteria and evaluation grades that were utilized are presented in Table 2.

The data obtained by evaluating each assessment criteria were statistically analyzed using the Chi-square test at a significance level of p=0.05.

RESULTS

A total of 300 porcelain laminate veneers were evaluated at baseline, one-year, two-years and five-years, respectively. Results for the USPHS criteria are presented in Table 3. Inter-year and inter-group comparisons revealed no statistically significant differences between the total-etch and self-etch groups in terms of USPHS criteria (p>0.05). The results for Group 1 are as follows:

Marginal Adaptation: At baseline and one-year recall, all porcelain veneers rated Alpha in terms of marginal adaptation. At the second- and fifth-year recall, 147 veneers presented Alpha. No veneers exhibited Charlie or Delta rate at any recalls.

Cavosurface Marginal Discoloration: At baseline, all veneers exhibited Alpha scores in terms of cavosurface marginal discoloration. One, one and two veneers presented a Bravo score at the one-year, two-year and five-year recalls, respectively. The rest of the veneers were scored as Alpha.

Secondary Caries: All veneers presented Alpha rate at baseline and the one-year, two-year and five-year recalls, respectively.

Postoperative Sensitivity: Postoperative sensitivity was only observed for 12 veneers at baseline. After subsequent self-etching primer and bonding agent application at the cervical and cavosurface margins, no sensitivity was observed for any restoration at all recalls.

Satisfaction with Restoration Shade: At baseline, all the veneers rated Alpha in terms of satisfaction with restoration shade. Two, two and three veneers presented Bravo at the end of the first, second and fifth years, respectively. The rest of the veneers were scored as Alpha.

Gingival Tissue Response: At baseline and one-year recall, all veneers exhibited Alpha in terms of gin-

Table 3: *Results for USPHS Criteria for Porcelain Veneer Restorations at Baseline, One-year, Two-years and Five-years*

Rating	Scores	Group 1 (n=150)				Group 2 (n=150)			
		Baseline	One Year	Two Years	Five Years	Baseline	One Year	Two Years	Five Years
Marginal Adaptation	A	150	150	147	147	150	148	148	148
	B	0	0	3	3	0	2	2	2
	C	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0
Cavosurface Discoloration	A	150	149	149	148	150	148	148	147
	B	0	1	1	2	0	2	2	3
	C	0	0	0	0	0	0	0	0
Secondary Discoloration	A	150	150	150	150	150	150	150	150
	B	0	0	0	0	0	0	0	0
Postoperative Sensitivity	A	138	150	150	150	142	150	150	150
	B	12	0	0	0	8	0	0	0
Satisfaction with Restoration Shade	A	150	148	148	147	150	149	149	148
	B	0	2	2	3	0	1	1	2
	C	0	0	0	0	0	0	0	0
Gingival Tissue Response	A	150	150	147	147	150	148	148	148
	B	0	0	3	3	0	2	2	2
	C	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0

gival tissue response. Three veneers were scored as Bravo at two- and five-year recall. The rest of the veneers were scored as Alpha.

The results for Group 2 are given as follows:

Marginal Adaptation: At baseline, all porcelain veneers are rated Alpha in terms of marginal adaptation. Two veneers were scored as Bravo at one-year, two-year and five-year recall, respectively. The rest of the veneers were scored as Alpha.

Cavosurface Marginal Discoloration: At baseline, all veneers showed Alpha scores in terms of cavosurface marginal discoloration. Two, two and three veneers exhibited a Bravo score at the one-year, two-year and five-year recalls, respectively. The rest of the veneers were scored as Alpha.

Secondary Caries: All veneers presented Alpha rate at baseline, one-year, two-year and five-year recalls, respectively.

Postoperative Sensitivity: Postoperative sensitivity was only observed with eight veneers at baseline. After subsequent self-etching primer and bonding agent application at the cervical and cavosurface margins, no sensitivity was observed for any restoration at all recalls.

Satisfaction with Restoration Shade: At baseline, all veneers scored as Alpha in terms of satisfaction with restoration shade. One, one and two veneers presented Bravo at the end of the first, second and fifth years, respectively. The rest of the veneers were scored as Alpha.

Gingival Tissue Response: At baseline, all veneers rated Alpha in terms of gingival tissue response. Two veneers were scored as Bravo at the one-year, two-year and five-year recall, respectively. The rest of the veneers were scored as Alpha.

DISCUSSION

Self-cure, dual-cure and light-cure resin cements are materials that can be used for the luting of porcelain veneers. It has been reported that simplified-step adhesive systems (self-etch adhesives) cannot be used in combination with dual-cure or self-cure resin cements, because of decreasing bond strength.[23-24] One factor that might contribute to this incompatibility is that the adhesives are more acidic in nature, and they tend to deactivate the basic amine catalyst of self- or dual-cured composites.[25] Due to the pH of the self-etch adhesive AdheSE (pH=1.7),[26] the current study used a light-cure composite for luting. Another potential factor is increased permeability of the simplified-step adhesives, because increased permeability precludes optimal polymerization and may deteriorate bonding.[27]

Light-cure luting composites have been used for the luting of porcelain veneers since 1989.[28] In the meantime, light-cure flowable composites introduced after 2001 have started to be used for the porcelain veneer luting procedure. In the current study, a light-cure hybrid composite was preferred due to its easier handling compared to flowable composites. In this study, Z100 hybrid composite was used in combination with total-etch or self-etch adhesive systems.

In clinical trials, modified USPHS criteria are mainly preferred for documenting outcomes. These criteria include marginal adaptation, cavosurface marginal discoloration, secondary caries, postoperative sensitivity, satisfaction with restoration shade and gingival tissue response.[22] The same criteria were used in the current study, because they enable the assessment of multiple

parameters and provide reliable information regarding the overall long-term success of the restorations. A long-term study indicated that the success rates of porcelain veneers were as high as 94% to 95%.[29] In the current study, the success rates of porcelain veneers were also observed in similar ranges.

The reason for the successful marginal adaptation and detection of no secondary caries in both techniques may be the fact that the boundaries of the veneer preparation were left within enamel in all cases. Meanwhile, the teeth to be restored possessed no caries or restoration prior to the veneer procedure. In a previous study, it has been reported that microleakage of restorations using self-etch adhesives could have resulted from incomplete etching of the enamel surface by acidic monomers.[30] Another study showed that acid etching prior to application of the self-etching primer produced higher bond strengths to enamel than self-etch priming only.[20] Since high bond strength to enamel is critical for good margins and seal of the restorations, applying the etching step should be considered for restorations that rely mainly on enamel bonding.[20] For these reasons, in the current study, enamel cavosurface margins were also etched with 37% phosphoric acid for 15 seconds before the self-etch adhesive application in Group 2. In the current study, acid etching was not applied to the dentin surface because of lower shear bond strengths that were reported in dentin when phosphoric acid was used in association with either adhesive system.[21,31]

The acid-etching procedure before the self-etching primer application in Group 2 may negate any difference that might have been observed between the systems. The results at the mesial, distal and incisal cavosurface margins may be similar to the total-etch group. However, the cervical region is not etched and is one of the most affected areas in a porcelain veneer. Therefore, the clinical performance of these different adhesive systems may be of importance in terms of gingival tissue response, marginal adaptation, cavosurface discoloration, secondary caries, postoperative sensitivity and satisfaction with restoration shade at the cervical region.

Another influencing factor on margin performance, especially at the cervical region, may be the selection of patients with good oral hygiene. Teeth that were scored as Bravo presented abrasion lesions before tooth preparation. The abrasion and erosion lesions at the beginning exposed the dentin but were covered with veneers. Tooth wear was not observed at the end of the current study, due to providing tooth brushing instructions at baseline. The shiny and esthetic effect of the veneers may also be a factor for further improvement in brushing methods.

The fact that there were no previous restorations in the teeth and finishing was done on enamel may have contributed to the 95% Alpha score for total-etch group and the 92% score for the self-etch group in terms of cavosurface marginal discoloration. Cavosurface marginal discoloration may be affected by the acid etching of enamel in both groups. The gingival margins were finished supragingivally, which may also play a role in decreasing cavosurface marginal discoloration. No statistically significant difference was observed between the total-etch and self-etch group in terms of cavosurface marginal discoloration. In the meantime, the fact that non-smokers were selected is another factor for less cavosurface marginal discoloration in both groups. Bravo scores also may have been caused by excess light-cured luting material. Any stained excess was removed at each recall.

Postoperative sensitivity is more frequently observed with two-step adhesives. The total-etch system used in the current study is a three-step technique, and post-operative sensitivity is scarcely observed after usage of this system in composite restorations. The results of the current study indicate that, similar to the results obtained for composites, this system causes a minimal amount of post-operative sensitivity after the luting of porcelain veneers as well.

Postoperative sensitivity was observed in cases (12 teeth restored with veneers for Group 1 and eight for Group 2) where a previous erosion existed at the initial examination. In such cases, a subsequent self-etching primer and bonding agent application was performed at the cervical, palatal and approximal regions of the veneers at baseline. With such a treatment approach, hypersensitivity subsided in all cases, and there was no necessity for a second application of desensitizer. There was no statistically significant difference between total-etch and self-etch adhesive systems in terms of postoperative sensitivity at all recall periods. Polymerization was performed through the porcelain veneer that may have slowed polymerization shrinkage, which may be another explanation for the low postoperative sensitivity rate.[32] In addition, the curing procedure was carefully performed for 40 seconds at the labial, margin and palatal areas, respectively. The curing procedure and adequate light intensity of the curing device are also important factors in terms of postoperative sensitivity.

The degree of satisfaction with restoration shade is correlated with the patient and dentist. At the baseline recall, all cases exhibited a slight darkening in the shade of the restoration. This situation remained stable over the next five-year period. The slight discoloration observed in the first week may be due to water sorption of the resin composite.[33-34] The reason why the majority of cases displayed an Alpha score throughout the five-year recall may due to including only non-smokers. The cases where discoloration occurred (Bravo with an aver-

age of 6% of 300 teeth) may be related with the excessive consumption of tea or coffee. At the end of this study, satisfaction with the restoration shade was not dependent upon the adhesive material used.

It has been reported that color stability of light-cured composites is superior compared to dual-cured or chemically-cured materials.[1] Therefore, a light-cured hybrid composite was selected as the luting material for the porcelain veneers. Another major advantage of hybrid composite is the ease of removal of excess material during the luting procedure.

Gingival tissue response showed a high success rate after the five-year recall. The reason for this may be the supragingival tooth preparation and selecting patients with good oral hygiene. In the one-week follow-up, cervical regions and gingival embrasures were polished with conically-shaped polishing burs. This procedure provided a favorable cervical adaptation of the restoration and subsequent healthy status of the gingiva. At the one-year recall, 16 veneers exhibited gingivitis, and swelling and bleeding were observed for 10 veneers. The gingival tissue response evaluation criteria may not be related to the adhesive system.

In the current study, no calculus formation may be due to the selection of upper teeth and patient hygiene. Regarding gingival health, the results of the current study are parallel to the findings of authors who observed no change in gingival health adjacent to the restored teeth.[35-38] Swelling and bleeding were occasionally observed at the papilla. Therefore, the shape of the gingival embrasure is a very important factor on gingival health. Gingival embrasure shape was modified in these cases.

Perfect adhesion to tooth structure is affected by several factors, such as a material's physical characteristics, polymerization sources, cavity location and configuration (C-factor), morphological and histologic composition of dentin, occlusion components, lack of strict adherence of the manufacturers' instructions and inconsistent clinical techniques by the practitioner.[8,16,39-40] The high success rate observed with porcelain veneers in the current study may be attributed to the suitable selection of tooth surface, adequate hydrofluoric acid etching of the porcelain veneers and silanization, easy application of light-cure composite, bonding capacity of adhesive materials and type of curing procedure.

Marginal adaptation, cavosurface marginal discoloration, secondary caries and post-operative sensitivity included among the USPHS criteria are directly related to the performance of adhesive systems used in the current study. When these criteria are assessed, it can be concluded that no statistically significant difference existed between the two adhesive systems.

The reason that no statistically significant difference was observed between total-etch and the self-etch systems may be attributed to adhesion of the restoration to a relatively larger surface and exposure to minimal masticatory forces in the facial region as compared to posterior restorations, such as posterior composites and inlays. Furthermore, the location of the veneer restoration enables an easier accomplishment of oral hygiene procedures. Consequently, the occurrence of complications, such as secondary caries, is less likely. Both systems can be used confidently in clinical practice.

In the current study, porcelain veneer technology has demonstrated a five-year clinical success for total-etch and self-etch adhesive systems. Further studies may focus on the clinical performance of all-in-one adhesive systems used with porcelain veneer luting materials.

CONCLUSIONS

Based on the findings of this *in vivo* study, it may be concluded that porcelain laminate veneers presented a successful clinical performance in terms of marginal adaptation, cavosurface marginal discoloration, secondary caries, postoperative sensitivity, satisfaction with restoration shade and gingival tissue response using both total-etch (Scotchbond Multi-Purpose Plus) and two-step self-etch (AdheSE) adhesives at the end of five years.

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