Direkt ve indirekt yöntemle yapılan kompozit rezin laminate veneer restorasyonların klinik değerlendirilmesi: 1 yıllık kontrol

Clinical evaluation of direct and indirect resin composite veneer restorations: 1 year report

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ÖZ

GİRİŞ ve AMAÇ: Bu çalışmanın amacı, farklı tekniklerle uygulanan kompozit rezin laminate veneer (RLV) restorasyonların bir yıllık klinik performansını değerlendirmektir.

YÖNTEM ve GEREÇLER: İlk 15 diş, Esthet•X HD (Dentsply DeTrey, Konstanz, Almanya) ile indirekt kompozit RLV restorasyonlarla; sonraki 15 diş Ceram•X Duo (Dentsply DeTrey) ile direkt kompozit RLV restorasyonlarla restore edildi. Başlangıç, 6 ve 12 ayda restorasyonlar modifiye Ryge kriterleri, cep derinliği, plak indeksi ve diş eti indeksi kullanılarak değerlendirildi. Klinik kriterlerin değerlendirilmesinde Mann Whitney U testi kullanıldı. Cep derinliği ölçümleri için Friedman testi kullanıldı. Plak ve diş eti indeksindeki farklılıklar Fisher'in kesin testi ve Oran karşılaştırmaları testi ile analiz edildi.

BULGULAR: Mann Whitney U testi sonucunda, gruplar arasında sadece kenar renklenmesi kriterinde istatistiksel olarak anlamlı fark bulundu ($p \leq 0.05$). İndirekt grupta 6. ay kontrolünde cep derinliği ve gingival indeks skorları arttı, bu artış istatistiksel olarak anlamlı bulundu ($p \leq 0.05$). Bu kriterlere göre direkt tekniğin indirekt teknikten istatistiksel olarak anlamlı ölçüde daha iyi olduğu tespit edildi ($p \leq 0.05$).

TARTIŞMA ve SONUÇ: Bu çalışmanın bulgularına dayanarak, her iki teknikle yapılmış kompozit RLV restorasyonlar anterior dişlerde estetik problemi olan hastalarda iyi birer tedavi seçeneği olabilir. Ancak erken dönem kenar renklenmesi, preparasyon, ölçü ve yapıştırma aşamasındaki zorluklar indirekt tekniğin dezavantajları olarak karşımıza çıkmaktadır.

Anahtar Kelimeler: Laminate veneer, kompozit, indirekt teknik

ABSTRACT

INTRODUCTION: The objective was to evaluate one year clinical performance of composite veneers applied with different techniques.

METHODS: The first 15 teeth were restored with an indirect technique with Esthet•X HD (Dentsply DeTrey, Konstanz, Germany), the next 15 teeth were restored with a direct approach with Ceram•X duo (Dentsply DeTrey). At baseline, 6 and 12 months, the restorations were evaluated using modified Ryge criteria, pocket depth, plaque index and gingival index. Mann Whitney U test was used in evaluating clinical criteria. Friedman test was used for pocket depth measures. Differences in plaque and gingival index were analysed by Fisher's exact test and Proportions test.

RESULTS: Regarding Mann Whitney U test, only the marginal discoloration criteria was statistically significantly different between the groups ($p \leq 0.05$). In the indirect group, the pocket depth and gingival index scores were increased at 6 month recall and these increases were statistically significant ($p \leq 0.05$). Direct technique was found to be statistically significantly better than the indirect technique ($p \leq 0.05$).

DISCUSSION AND CONCLUSION: Based on the findings of this study, both composite veneer techniques may be a good treatment option for patients with esthetic problems in anterior teeth. However, early discoloration rate, complex approach with preparation, impression and luting are the disadvantages for indirect technique.

Keywords: *Laminate veneers, composite, indirect technique*

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Introduction

Dental treatments not only rehabilitate speech and masticatory functions, but they also improve the aesthetics by refining the color, position, shape, and size of the teeth, as well as the overall smile appearance. The mouth and the eyes are the most attractive parts of the face because of their dynamic color-contrasting characteristics. Possessing a harmonious and beautiful smile can play key roles in an individual's self-confidence and effective communication. However, not everyone has a naturally perfect smile. The developments that have been made in dental materials, especially resin composites and adhesives, have enhanced the clinical performance of resin composite laminate veneer restorations, which allows for the option of minimally-invasive procedures.[1]

Laminate veneer restorations are produced using two different techniques: direct and indirect. Depending on the material used, these restorations can be divided into 3 subgroups: acrylic resin, resin composite, and ceramic. Often, acrylic veneer restorations do not meet the patient's aesthetic expectations, and they have limited durability and high water sorption properties; therefore, they are no longer in use.[2] Ceramic laminate veneer restorations have become very popular over the last two decades, but they are very expensive. Additionally, the color stability of these materials is high as a result of their resistance to water sorption, and they are highly resistant to abrasion. Moreover, the strength of brittle ceramic materials increases after their cementation. However, there are some disadvantages to using these materials, such as the need for deeper preparation, a long waiting period for laboratory procedures, the numerous sessions that are required, the high cost, and the fact that they cannot be repaired. Additionally, there are still problems with regard to laboratory color matching, especially when the underlying dental tissue is not masked.[3]

The indications for indirect resin composite laminate veneers are quite similar to those of ceramic veneers, but they are cheaper; however, they have less resistance to abrasion. Moreover, because of the laboratory procedures required for these veneers, extra clinical sessions are required. The resin composite material is more opaque than the ceramic material, and it can better mask any underlying dark discolorations.[4] Moreover, the finishing and polishing outcomes are superior to those of the direct resin composite veneer restorations because these restorations are completed extraorally. For this reason, the indirect technique tends to be more successful than the direct technique, especially for patients with less than ideal oral hygiene. However, the cost of direct resin composite veneer restorations is low, the duration of the treatment is short, repairs can be made, and the polishing process can be repeated many times, when compared to ceramic veneers. Nevertheless, their abrasion resistance, polishability, and color stability are lower.[5]

As an alternative to direct laminate veneer restorations, prefabricated resin composite veneers were introduced, and they are both aesthetically pleasing and practical. Their improved composition and degree of polymerization conversion under laboratory conditions result in enhanced strength, color stability, and hardness, when compared to direct resin composites. In addition, they are cheaper when compared to ceramic laminate veneer restorations.[6] Although these properties have brought prefabricated resin composite veneers to the forefront of clinical practice, the longest follow-ups reported for these veneers were no longer than 1 year.[1]

There have been many studies comparing the clinical performance of laminate veneer restorations in the literature.[3,4,7] When they are made for the proper indications using the right techniques, the aesthetic and surface properties of these restorations can exhibit results similar to the appearance of natural teeth, and their clinical success rate is quite high.[7]

In light of the abovementioned information, the objective of this clinical study was to evaluate the 1-year clinical performances of different resin composite laminate veneers applied using direct and indirect techniques.

Materials and Methods

Patient Selection

This randomized clinical trial included patients admitted to the Ege University School of Dentistry. Before taking part in this study, a total of 12 patients were provided with informed consent forms approved by the ethics committee (Ege University, Medical Faculty Ethics Committee, number: 13-11/90). The subjects were selected randomly from those patients who met the inclusion criteria as follows: between 18 and 35 years old, physically and psychologically able to return for the follow-up appointments, normal occlusion with opposing and adjacent teeth, no parafunctional habits, no active periodontal or pulpal diseases, and no previous restorations in the anterior region. For this study, numbers were produced to allow for the same chance for each individual to be included in one of the two groups, and the randomization was done according to these numbers. The odd-numbered patients were treated using the direct approach, and the even-numbered patients were treated using the indirect approach. The research budget restricted the size of the sample; therefore, a power

analysis was not performed at the beginning of the study.

Direct and Indirect Restorations

Thirty resin composite veneer restorations, 15 direct and 15 indirect, were applied to the patients included in this study by a single operator. Before the treatment procedures began, the pocket depths, gingival indexes, and plaque indexes were recorded for each patient as indicators of the periodontal status. The pocket depth measurements were recorded by measuring the distance from the pocket to the edge of the gingiva using a periodontal probe (PCP-UNC 15 Hu-Friedy, Leimen, Germany). In order to be more objective, the tooth color was determined using a spectrophotometer (SpectroShade Micro; MHT Optic Research AG, Niederhasli, Switzerland), and each patient's consent was obtained. Ceram•X duo (Dentsply DeTrey, Konstanz, Germany) was used for the direct veneer restorations (Figure 1A–C) and Esthet•X HD (Dentsply DeTrey) was used for the indirect veneer restorations (Figure 2A–C). The manufacturers, materials, compositions, and application procedures for the materials that were tested are shown in Table 1.

Figure 1A-C. Direct veneer restorations performed with Ceram-X Duo; A: Initial situation, B: 6 months recall, C: 12 months recall

Figure 2A-C. Indirect veneer restorations performed with Esthet-X; A: Initial situation, B: 6 months recall, C: 12 months recall

A retractor was placed around the mouth to provide a good field of view (OptraGate; Ivoclar Vivadent, Schaan, Liechtenstein), and the area was isolated using suction and cotton rolls. No preparations were made for the direct restoration group. The entire enamel surface was etched for 30 seconds with 36% phosphoric acid (DeTrey Conditioner 36; Dentsply DeTrey); then, it was rinsed for 30 seconds with a water spray. Prime & Bond NT (Dentsply DeTrey) was applied to the surface of each tooth, it was spread lightly using air, and it was polymerized for 10 sec with an LED light curing device (Elipar S10 LED Curing Light, 1,200 mW/cm²; 3M ESPE, St. Paul, MN, USA). The restorations were completed with a multi-layering technique using the Ceram•X duo resin composite material. The layers were polymerized for 40 seconds for the dentin shades and 10 seconds for the enamel shades.

Gingival retraction (Ultrapack Cord, size 1; Ultradent Products, Inc. Salt Lake City, UT, USA) was performed for the indirect restorations, and a minimal chamfer preparation was made at the gingival level, with the remaining enamel being preserved as much as possible (879m-014 FG; KOMET Deutschland GmbH, Besigheim, Germany). Impressions were taken after the preparation (Elite HD, Zhermack, Germany), and cast models were obtained. A separator was applied to the cast models to prevent the indirect resin composite material from sticking to the models. All of the restorations were completed on the cast models by the same operator using a layering technique with the Esthet•X HD resin composite material, which was light-cured. Then, a Triad Light Curing Unit (Dentsply Trubyte, Canada) was used for two minutes for the secondary polymerization of the indirect resin composite material. The restorations were then sandblasted with 50-µm Al2O3 particles (Korox, Bego, Bremen, Germany). The indirect restorations that were obtained were placed in the mouth (Variolink II Try-In paste; Ivoclar Vivadent) to determine the marginal adaptation, interproximal fit, anatomical form compliance, contours, and relationships to one another. No temporary restorations were made because the preparation boundaries were left on the enamel as much as possible, and the indirect restorations were cemented the day after the preparation.

Table 1. Composition and application procedures of the tested materials

Materials	Manufacturer	Material type	Composition	Application procedures
Ceram-X Duo	Dentsply DeTrey, Konstanz, Germany	Nano ceramic restorative material	**Resin matrix:** ORMOCER, DM ethyl1-4, (dimethyl lamino) benzoate **Filler combination**: Barium-aluminum-borosilicate, glass, SiO_2, nanofiller	First rebuild the dentin core with dentin shade (light cure for 40 sec). Then add the enamel layer with the enamel shade (light cure for 10 sec).
Esthet-X HD	Dentsply DeTrey, Konstanz, Germany	Microhybrid restorative material	**Resin matrix**: Bis-GMA, Bis-EMA, triethylene glycol dimethacrylate, camphoroquinone, photoinitiator, stabilizer, pigments. **Filler combination:** Barium fluoroborosilicate glass and nanofiller silica.	Rebuild the restoration with the Esthet X HD and light cure for 20 sec. Then post-cure the restoration (Triad, Dentsply Trubyte, Canada, USA) 2 min.
Prime & Bond NT	Dentsply DeTrey, Konstanz, Germany	One step Etch &Rinse adhesive system	Di- and trimethacrylate resins, PENTA, nanofillers-amorphous silicon dioxide, photoinitiators, stabilizers, cetylamine hydrofluoride, acetone	Etch 15 s, rinse and dry gently. Apply primer/bond, leave 20 sec, gently air dry, light-cure 10 sec
Variolink II	Ivoclar Vivadent AG, Schaan, Lichtenstein	Dual-polymerizing resin cement	**Monomer matrix:** bis-GMA, urethane dimethacrylate, triethylene glycol dimethacrylate **Inorganic fillers:** barium glass, ytterbium trifluoride, Ba-Al-fluorosilicate glass, spheroid mixed oxide	Etch only the enamel (37% phosphoric acid) 15 sec, rinse, air dry, apply Syntac primer 15 sec, air dry, apply Syntac adhesive 10 sec, air dry, apply Heliobond
Enhance/ PoGo	Dentsply Caulk Milford, DE, USA	2-step finishing and polishing system	**Enhance:** Polymerized Urethane Dimethacrylate Resin, Aluminum Oxide, Silicon Oxide, Plastic latch-type mandrel. **PoGo:** Polymerized Urethane Dimethacrylate Resin, Fine Diamond Powder, Silicon Oxide, Plastic Latch-type mandrel	Finish with Enhance disc, cup or point. Polish with Pogo polishing disc, cup or point.
Sof-Lex discs	3M ESPE, St Paul, MN, USA	Multi-step finishing and polishing system	Corse aluminum oxide discs (100 µm/150 grit) Medium aluminum oxide discs (40µm/360 grit) Fine aluminum oxide disks (24µm/600 grit) Ultra fine aluminum oxide discs (8µm/200 grit)	Used from coarse to superfine step-by-step.

Before the cementation, the teeth were cleaned with pumice and water to remove all of the remaining debris. Then, Mylar strip bands and wedges were placed to prevent the restoration from sticking to the neighboring teeth. DeTrey Conditioner 36 with 36% phosphoric acid was applied to the internal and dental surfaces of the restorations for 20–30 seconds; then, they were rinsed for at least 20 seconds and lightly dried. Variolink II paste was applied according to the manufacturer's instructions, and the resin was carefully placed on the inner surfaces of the veneers and the tooth surfaces. All of the adhesive cement residue was removed carefully using a probe. Prior to the initiation of the polymerization process, the proximal sides were scraped with dental floss to remove the excess cement. For each tooth, the buccal and palatal surfaces were polymerized for 40 seconds (Elipar S10 LED Curing Light, 1,200 mW/cm²). For all of the restorations, the resin cement was removed with a carbide finishing kit (Kit 4525A, Komet, Besigheim, Germany). The proximal cement residue was removed using interdental polishing strips (3M ESPE). The occlusion was controlled with articulation paper, and any premature contact areas were removed. Sof-Lex coarse and medium contouring discs (3M ESPE) were used, followed by Enhance finishing points (Dentsply Caulk, Milford, DE, USA). PoGo discs and points were used to polish the restorations (Dentsply Caulk).

Clinical Evaluation

All of the restorations were evaluated after one week with regard to the baseline records. Then, at 6 and 12 months, the restorations were evaluated again by two trained clinicians (not including the one who did the restorations) using the modified Ryge Criteria for the retention rate, marginal adaptation, marginal discoloration, secondary caries, postoperative sensitivity, color match, and anatomical form (Table 2). When there was a difference between the two evaluators' scores, the score was chosen by consensus. For the statistical analysis, the scores of the restorations were coded as follows: an Alpha score was 3, a Bravo score was 2, and a Charlie score was 1. In addition, the pocket depth, plaque index, and gingival index (Table 3) were also evaluated using a periodontal probe (PCP-UNC 15).

Table 2. Modified Ryge Criteria Rating System

Category and Rating	Criteria*
Retention Rate	A : Retained B : Partially retained C : Missing
Marginal Adaptation	A : Undetectable crevice along the margin B : Detectable V-shaped defect in enamel only margins. C : Detectable V-shaped defect in DEJ
Marginal Discolouration	A : No discoloration anywhere along the margin between the restoration and the tooth structure B : Superficial staining (removable, usually localized) C : Deep staining (not removable, generalized)
Secondary Caries	A : No evidence of caries B : Evidence of caries along the margin of the restoration
Postoperative Sensitivity	A : No postoperative sensitivity B : Experience of sensitivity at any time of the restorative process and during the study period
Colour Match	A : No shade mismatch B : Perceptible mismatch but clinically acceptable C : Aesthetically unacceptable
Anatomic Form	A : The restoration is continuous with Visually B : Generalized wear but clinically acceptable (50% of margins are detachable, catches explorer going from material to tooth) C : Wear beyond the DEJ (clinically unacceptable)

*A=Alpha; B=Bravo; C=Charlie

Table 3. Criteria for the plaque and the gingival index system

The Plaque Index System
0 = No plaque in the gingival area.
1 = A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may only be recognized by running a probe across the tooth surface.
2 = Moderate accumulation of soft deposits within the gingival pocket, on the gingival margin and/or adjacent tooth surface, which can be seen by the naked eye.
3 = Abundance of soft matter within the gingival pocket and/or on the gingival margin and adjacent tooth surface.
Gingival Index System
0 = Normal gingiva
1 = Mild inflammation — slight change in color, slight oedema. No bleeding on probing.
2 = Moderate inflammation—redness, oedema and glazing. Bleeding on probing.
3 = Severe inflammation — marked redness and oedema. Ulceration. Tendency to spontaneous bleeding.

Statistical Analysis

The results were analyzed using IBM SPSS Statistics for Windows (Version 22.0; IBM Corp., Armonk, NY, USA). The Mann-Whitney U test was used because the statistical requirement for meeting a normal distribution was not achieved when evaluating the clinical criteria. The descriptive statistics included the median, interquartile range, mean, and standard deviation. For the pocket depth measurements, the Friedman test was used for the multiple comparisons between the related intervals. The differences in the plaque and gingival indexes were analyzed using Fisher's exact test and the test of proportions. At the end of the study, the power of the test for each criterion was calculated using the G*Power software program (Version 3.1.10; Heinrich Heine University, Düsseldorf, Germany).3

Results

A total of 30 laminate veneers were evaluated at the baseline, at 6 months, and at 12 months. The results of the modified Ryge Criteria according to the evaluation periods are shown in Table 4, and the gingival tissue scores are shown in Table 5.

Table 4. Statistical analysis results at 12-month recall using Modified Ryge Criteria.

	Direct (n:15)		**Indirect (n:15)**		**Mann Withney U**		**Power of test**
	Median (IQR)	**Mean±Std**	**Median (IQR)**	**Mean±Std**	**Z**	**P value**	
Anatomical form	3 (0)	2.91±0.29	3 (0)	2.87±0.34	-0.482	0.630	-
Marginal adaptation	3 (0)	2.91±0.29	3 (0.33)	2.80±0.40	-1.445	0.148	-
Marginal discoloration	3 (0)	3.00±0.00	3 (0.67)	2.76±0.43	-2.949	**0.003**	**0.948**
Color match	3 (0)	3.00±0.00	3 (0.03)	2.91±0.42	-1.439	0.150	-
Retention rate	3 (0)	3.00±0.00	3 (0)	3.00±0.00	-	-	-
Secondary caries	3 (0)	3.00±0.00	3 (0)	3.00±0.00	-	-	-
Postoperative sensitivity	3 (0)	3.00±0.00	3 (0)	3.00±0.00	-	-	-

Table 5. Scores of Clinical Evaluation (&) at baseline, 6-month and 12-month recall.

	Direct (n:15)			**Indirect (n:15)**		
	Baseline	**6-month recall**	**12-month recall**	**Baseline**	**6-month recall**	**12-month recall**
Plaque index						
0	60%	80%	100%	87%	80%	73%
1	40%	20%	0%	13%	20%	27%
Gingival index						
0	53%	53%	87%	53%	7%	33%
1	47%	47%	13%	47%	93%	67%

Table 6. Statistical analysis of pocket depth at baseline, 6-month recall and 12-month recall.

Direct Group	**Friedman**									
	Time	**N**	**Mean**	**Std Dev**	**Median**	**Minimum**	**Maximum**	**Mean Rank**	**Chi Square**	**p**
	Baseline	15	1,40	0,51	1	1	2	1,83	3,5	0,174
	6-month recall	15	1,47	0,64	1	1	3	1,9		
	12-month recall	15	1,67	0,49	2	1	2	2,27		
Indirect Group	**Baseline**	15	1,27	0,59	1	1	3	1,47	8,348	**0,015**
	6-month recall	15	1,87	0,64	2	1	3	2,27		
	12-month recall	15	1,80	0,56	2	1	3	2,27		

Modified Ryge Criteria

There was no difference between the scores of the two groups at the baseline and at the 6-month follow-up in terms of the overall modified Ryge criteria. At the 12-month follow-up, of the 15 veneers in the indirect group, two restorations showed superficial marginal discoloration (Bravo scores) (Figure 3). However, all of the veneers in the direct group showed Alpha scores with respect to this criterion, and the difference between the groups was statistically significant ($p<0.003$).

Figure 3. Slight marginal discoloration observed after 12 months in the indirect group

With regard to the marginal adaptation, the scores were more commonly in favor of Alpha scores in the direct group than the indirect group; however, this difference was not statistically significant ($p=0.148$). There was also a difference between the group scores in terms of the anatomical form; however, this difference was not statistically significant ($p=0.630$). All of the veneers in the direct group received Alpha scores with regard to the color match, and only two of the veneers in the indirect group received Bravo scores. This difference was not statistically significant ($p=0.150$). All of the veneers in both groups received Alpha scores with respect to the retention rate, secondary caries, and postoperative sensitivity.

Gingival Tissue Response

In the direct group, the pocket depth was increased at the 6-month and 12-month follow-ups; however, these increases were not statistically significant ($p>0.05$). There were statistically significant decreases at the 12-month

follow-up when compared to the 6-month follow-up for the plaque and gingival indexes in this group ($p<0.05$).

In the indirect group, the pocket depth was increased at the 6-month follow-up, and this increase was statistically significant ($p<0.05$). A statistically significant increase was also seen at the 6-month follow-up for the gingival index ($p<0.05$). There was no significant difference at the 12-month follow-up in terms of the gingival index ($p>0.05$). Despite the changes in the plaque index, the values were not statistically significant at either the 6-month follow-up or 12-month follow-up ($p>0.05$).

Discussion

This clinical trial was designed to compare the performances of resin laminate veneer restorations applied using two different techniques. The selection of a restorative material and the method to be used based on the patient's socioeconomic status, aesthetic expectancy, and oral hygiene is a prerequisite for clinical success.[8] In order for a restoration to be aesthetically pleasing, it must first exhibit a good color match with the neighboring teeth. The choice of color is affected by three factors: the light source, the object, and the observer. Color matching should be performed on clean teeth with the natural moisture of the oral cavity, because enamel dehydration reduces its translucency, which can mislead the clinician.[9] In order to eliminate any bias and provide an objective result, before the treatment, the color was determined with the help of a spectrophotometer.

Much more favorable physical properties of the materials can be obtained with the use of a rubber dam to prevent moisture contamination. However, successful results have also been reported in aesthetic restorations made using cotton rolls and suction, without rubber dam use.[10] We did not use rubber dams because sufficient isolation could be provided for both groups in the present study.

From a clinical point of view, the amount of intact enamel that remains after preparation is a key point in the success of a restoration. Because the quantity of the remaining enamel increases adhesion, the tooth preparations must be kept to a minimum. If the preparation is not done correctly, the cement will be in contact with the oral media due to the insufficient marginal adaptation of the restoration, and microleakage will occur in the cervical regions.[11] In this study, the marginal discoloration that was observed can be explained by the fact that the finishing lines not ending in enamel were not noticed because of the abrasive lesions in one patient with marginal discoloration. Furthermore, previous studies have shown that the enamel acid etching enhances the adhesion of the restoration by changing the topography to a low-reactive surface and increasing the bond surface area.[12]

Pena et al. investigated the 24-month clinical success of restoring non-carious cervical lesions with two self-etching adhesive systems applied with and without selective enamel etching using Esthet•X HD. The results were clinically acceptable, although increased marginal staining was recorded for the groups with Clearfil SE (Kuraray Noritake Dental, Tokyo, Japan) without etching and Xeno V (Dentsply DeTrey) with etching. The authors attributed these results to the acidic adhesive solution (pH~1.3) combined with phosphoric acid, which intensified the enamel etching.[13] Conversely, in this study, 36% orthophosphoric acid was applied for 30 seconds according to the manufacturer's recommendations, and no marginal discoloration was detected in the direct resin laminate veneer restorations. However, this may be attributed to the short evaluation period. Microleakage between the cement and the tooth or the cement and the veneer is one possible cause of the discoloration and loss of color stability of indirect restorations. Therefore, the choice of adhesive systems is very important.[14] We took great care to ensure that the preparation was located on the enamel, and that the adhesive system was applied according to the manufacturer's recommendations.

Manufacturers provide resin composites using different structures in order to enhance performance. Microhybrid and nanohybrid resin composites are the materials of choice for anterior restorations due to their high polishability and aesthetic properties. In the present study, Ceram•X duo was used because its nano-sized fillers exhibit superior properties in terms of polishability and translucency. Demirci et al.[15] evaluated 147 direct resin composite laminate veneer restorations, with 4-year survival rates of 92.8% for Filtek Supreme XT (3M ESPE)/Scotchbond Multi-Purpose Plus (3M ESPE) and 93% for Ceram•X duo/XP Bond (Dentsply DeTrey). They revealed that the nanohybrid and nano-resin composites may result in good quality restorations with good long-term results.[15] In addition, a study comparing the aesthetic properties of different resin composite materials concluded that Ceram•X duo was the material of choice for reducing the chair time, with aesthetically acceptable results.[16] Although microhybrid resin composites can be used in high-stress areas, a reduction in the brightness over time is one disadvantage of this group of materials. However, none of the patients in the indirect Esthet•X HD group complained about this during the follow-up appointments. Da Silva et al.[17] compared the polishing properties of two microhybrid and one nano-particle resin composites at different time intervals, and they revealed that the Esthet•X HD showed

the highest surface roughness levels. These results were compatible to the findings of Paravana et al.[18] and Lu et al.,[19] who also found greater roughness values. Contrarily, another study revealed lower roughness values for the Esthet•X HD when compared with the other microhybrid resin composite materials.[20] The choice of an appropriate resin composite is crucial for the clinical success of laminate veneers.[12,14] Esthet•X HD can be used with an indirect technique for inlay-onlay-overlay restorations, as specified in the manufacturer's instructions. In the present study, we wanted to evaluate the success of Esthet•X HD as an indirect anterior restorative material, based on the superiority of the marginal adaptation, proximal contacts, and polymerization shrinkage advantages of indirect techniques. Additionally, this material has a wide range of colors, which is the real reason why we chose the layering technique.

Although a lot of clinical data exists regarding direct resin composite laminate veneer restorations, long-term studies with microhybrid resin composite Esthet•X HD used an indirect technique are not available. One study[21] investigated 176 direct resin composite build-ups, obtaining a 5-year survival rate of 84.6%, while Lempel et al.[22] investigated 163 direct resin composite build-ups, and they obtained a 7-year survival rate of 88.34%. In addition, Gresnigt et al.[3] evaluated 96 direct laminate veneer restorations, and they reported a survival rate of 87.5% up to a maximum of 45.7 months. For comparison, the direct resin composite laminate veneer restorations in this study did not show any failures. Fractures or chipping failures make up a good part of the literature when microhybrid resin composites are used.[22] Moreover, Gresnigt et al.[23] reported surface roughness and marginal discoloration as the common relative failures after absolute failures. Correlatively, marginal discoloration also occurred in the present study; however, no absolute failures were seen, likely because the follow-up period was short.

Van Dijken et al.[24] revealed that bruxism had a significant effect on the fracture rate. From the beginning of the present study, bruxism patients were not included. Therefore, in addition to the short follow-up period, this exclusion criterion may explain the results showing no fractured restorations.

Polymerization completion is very important for clinical success. Inadequate polymerization results in water sorption and restoration discoloration. Water sorption causes hydrolytic degradation, which, in turn, reduces the wear resistance and mechanical properties of the restorative material.[25] Therefore, in the present study, the polymerization of the resin composite and adhesive material was performed in accordance with the manufacturer's recommendations. Polymerization shrinkage plays an important role in resin composite failures,[26] and as a result of this phenomenon, marginal leakage occurs.[27] In the present study, parallel to the literature, the authors believe that the marginal discoloration observed in the indirect group occurred due to the polymerization shrinkage of the resin cement. The changes in this criterion were influenced particularly by the findings of one patient, and the discoloration was easily polished away with the use of Enhance finishing points, followed by polishing with PoGo discs.

The degradation of the adhesive interface usually results in indirect laminate veneer restoration debonding, because there is no mechanically retentive preparation. Mechanically retentive restorations present no clinical outcomes, but when it comes to indirect laminate veneer restorations, the adhesion quality is an important issue to be considered.[4] The retention of indirect laminate veneer restorations depends mostly on the type of resin cement. These cement types are classified as etch and rinse, self-etching, and self-adhesive based on the adhesive system used. They can also be classified according to their polymerization mechanisms as light-cured, chemical-cured, and dual-cured. The literature shows that the success rates of the etch and rinse resin cement types are quite high.[28] Some of the disadvantages of these cement types are that they require technical precision, and their depth of polymerization may be insufficient when the restoration thickness is excessive, as in overlays.[28] In addition, if the adhesive resin is applied in a thick layer, polymerization shrinkage may occur, and more material is exposed to the oral fluids; therefore, the amount of degradation may increase.[2] Even though plenty of composite resin cements are available on the market for veneer cementation, flowable composite resins and preheated direct resin composite restorative materials have been proposed because of their proven color stability and better marginal adaptation, which are comparable to light-polymerized cement.[29] One previous study revealed that with regard to both fatigue and load to failure tests, the use of a preheated restorative resin composite instead of a resin composite cement would be advantageous.[30] However, there are no long-term clinical trials proving these effects. Therefore, in this study, Variolink II was used as an etch and rinse resin cement due to its proven success with many years in the literature.[31] The authors believe that the marginal discoloration, which occurred at the end of the first year, may have been caused by some mistakes that occurred in the resin cement application stages. Moreover, the resin cement may have changed the clinical outcomes of the polymerization shrinkage and marginal discoloration scores due to microleakage.

The finishing and polishing processes play key roles in the lifespan of resin composite restorations. Well-polished surfaces increase the aesthetics and improve

the cleanability of the restorations. Moreover, the lesser plaque retention on the smooth surfaces results in a reduced secondary caries risk.[32] Moreover, the oxygen inhibition layer, also known as an uncured layer of resin,[33] if not removed by polishing, can also cause marginal discoloration.[34] For these reasons, more attention was paid to the finishing and polishing procedures of the restorations.

The success of resin composite restorations has been the subject of many clinical studies.[3,23] The modified Ryge Criteria are still in use because they provide an objective, easy to use, and permissive method. The application is easy, and this method allows for the evaluation of 7 criteria, including the retention rate, marginal adaptation, marginal discoloration, secondary caries, postoperative sensitivity, color matching, and anatomical formation.[35] The lifespan of the restorations may vary depending on the patient and many other factors, including the patient's oral hygiene, masticatory forces, occlusal habits, nutrition, salivary enzymes, the properties of the materials used, and the experience and skill of the dentist.[36] We attempted to eliminate the influences of these factors as much as possible, with all of the restorations being performed by a single operator. Additionally, the restorations were evaluated by two experienced clinicians, independently, during the follow-up sessions. In those cases in which there were inconsistencies between the evaluations, the scores were assigned by consensus.

Regarding the longevity of dental restorations, clinical trials are the best way to evaluate the success rate. However, the presence of many variables in the oral environment makes it difficult to pinpoint the exact cause of clinical failures. As with any clinical trial, there were also some limitations in the present study. For example, two different resin composite material types were used. When the practice area is the patient, it is impossible to standardize the oral environment, preparation amount, and remaining dental tissue. When considering factors other than those that are patent-related, the authors believe that further studies are needed to evaluate both of the resin laminate veneer restorations in the same mouth. Another limitation was the short evaluation period of 1 year. This follow-up period for evaluating the long-term clinical behavior of any restorative material is very short, and a longer clinical follow-up study should definitely be performed.

Conclusion

Based on the findings of this 1-year clinical study, it may be concluded that both techniques used to perform resin composite veneers presented acceptable results. However, early discoloration rate, complex approach with preparation, impression and luting steps are the disadvantages of the indirect technique. Furthermore, we have seen that the gingival response to the restorations changed over time due to the lack of oral hygiene habits of the patients.

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