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A Five-Year Clinical Evaluation of Direct Nanofilled and Indirect Composite Resin Restorations in Posterior Teeth

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Clinical Relevance

Under clinical conditions, posterior direct nanofilled composites and indirect composite inlay systems have the potential to present a high success rate and were clinically satisfactory at five years postplacement.

SUMMARY

Aim: To assess the clinical efficacy of posterior composite resin restorations placed directly and indirectly in posterior teeth after five years.

Materials and Methods: A total of 108 cavities in 54 patients were restored with three direct composite resins (Filtek SupremeXT [FSXT], Tetric Evo Ceram [TEC], AELITE Aesthetic [AA]) and two indirect composite resins (Estenia [E] and Tescera ATL [TATL]). All restorations were evaluated by two examiners using the United States Public Health Service criteria at baseline and five years after placement. Statistical analysis was completed with Fisher exact and McNemar χ^2 tests.

Results: At baseline, 4% (five) of the restored teeth presented postoperative sensitivity; however, only one of them (a member of the E group) required canal treatment and replacement after two years. At the five-year evaluation, all restorations were retained, with *Alpha* ratings at 100%. Only one tooth (in the TEC group) required replacement after three years due to secondary caries. Color match, surface texture, and marginal integrity were predominantly scored as *Alpha* after five years for all

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groups. After that time, marginal discoloration was scored as *Alpha* in 64% of AE restorations, 70% of TATL restorations, 73% of E restorations, and 87% of FSXT restorations. There were no *Charlie* scores recorded for any of the restorative systems.

Conclusions: Under controlled clinical conditions, indirect composite resin inlays and direct composite resin restorations exhibited an annual failure rate of 2.5% and 1.6%, respectively, after five years. Therefore, the investigated materials showed acceptable clinical performance, and no significant differences were found among them.

INTRODUCTION

In recent decades, esthetic considerations have played an increasingly greater role in the treatment planning of dental care, even in the restoration of posterior teeth.[1] For this reason, in addition to their largely improved biomechanical properties, direct composite resin restorations are now routinely used as a metal-free alternative to posterior restorations.[2] Another laudable advantage presented by this procedure is that it allows for the maximum preservation of tooth structure, which concurs with the modern concept of a conservative approach to restorative dentistry.[3] However, early experiences with the direct restorative treatment method indicated that there were more clinical challenges and higher failure rates in these types of restorations than in amalgam restorations.[4] The materials, techniques, and instruments used in the current restorative dentistry landscape for placing these posterior composite restorations have improved since their early days.[5] Esthetic alternatives to cast gold inlays and amalgam restorations include glass ionomers, compomers, direct composites, composite inlays, and ceramic inlays.

Good long-term clinical performance of restorations enhances the general health and satisfaction of patients. Therefore, it is of interest and importance for patients, dentists, and funding agencies to understand the longevity of dental restorations.[6,7] Nevertheless, the clinical and biological longevity of adhesive restorations is dependent on the performance of the adhesive systems.[8] Bonded restorations require accurate use of adhesive techniques and knowledge about complex bonding mechanisms.[9] The available composite materials indicated for posterior restorations, hybrid and microhybrid composite resins, have high filler loading (more than 60% in volume) with reduced mean particle size (ranging between 0.4 and 1.0 μm). These features provide optimal wear resistance combined with adequate mechanical properties. However, these resins are difficult to polish, and surface gloss is lost quickly.[10] Microfilled resins have filler particles 0.04 μm in diameter. These resins have high surface polish and satisfactory color stability. However, microfilled composite resins with low filler loading are not as mechanically resistant as the hybrid resins.[11] For direct composite resins to be considered as an alternative to small- to medium-sized cavities in posterior teeth,[12] various aspects of the patient's occlusion must be examined before surgery, such as the occlusal contacts, the type of restorations in the opposing dentition, the presence of wear facets, and the position of the tooth within the arch. Having considered such factors, favorable or desired esthetic results can be predictably achieved with posterior composite restorations.

Recently, due to increasing demand for a universal restorative material indicated for all types of direct restorations, including posterior teeth, a new category of resin composite has been developed: nanofilled composites.[3] These are distinguished from microfilled composites by their loading percentage and the characteristics of their filler particles. Compared with nanofilled composites, microfilled composites are limited in the amount of inorganic filler loading. Microfilled composites present nearly 37% to 40% volume filler loading, whereas nanofilled composites have approximately 60% volume filler loading.[11] Regarding esthetics, strength, and durability, dental nanocomposites show high translucency, high polish, and polish retention, similar to the properties of microfilled composites, while maintaining physical properties and wear resistance equivalent to those of several hybrid composites. Therefore, by virtue of the strength and esthetic properties of resin-based nanocomposites, clinicians and dental practitioners can use these materials for both anterior and posterior restorations.[13]

Apart from direct composite resin restorations, indirect laboratory-processed composite resin systems are also an esthetic alternative for intracoronal posterior restorations. Laboratory-processed inlays/onlays fabricated with composite resins provide excellent esthetic results that may also reinforce tooth structure.[14] These results are possible because a more conservative preparation design can be used, due to the bonding procedures strengthening the cusps and providing additional support for the dentition. Additional clinical benefits include precise marginal integrity, wear resistance similar to enamel, wear compatibility with opposing natural dentition, ideal proximal contacts, and excellent anatomic morphology.[15]

Before a restorative material can be applied clinically, its performance must be screened and evaluated using *in vitro* studies.[16] Laboratory studies produce meaningful results for relatively short periods of time and can also evaluate the effect of a single variable while keeping all other variables constant. However, it is difficult to provide a direct correlation between the *in vitro* and *in vivo* performance of an adhesive restorative system. Thus, laboratory studies do not always reflect the clinical behavior of the material due to the differences between laboratory and clinical conditions.[17] These differences result from the fact that the three-dimensional configuration of a prepared tooth is inherently different from the flat surfaces that are usually used to test adhesive materials in the laboratory. Additionally, the bonded interface is subjected to a variety of different stresses and more challenging situations over time *in vivo*.[16] For these reasons, clinical evaluations of direct and indirect resin-based composite restorations, which are placed using the currently available range of commercial restorative materials, are needed to substantiate and corroborate the data obtained from the *in vitro* studies of these materials. The relevant criteria can be applied consistently during clinical trials to assess the performance of restorations[18] using the United States Public Health Service (USPHS) evaluation system, which is the most commonly used direct method for the quality control of restorations.[19] This scoring system was designed to provide comprehensive evidence for clinical acceptance, rather than for degrees of clinical success.

The aim of this study was to compare the clinical performance of three conventionally placed nanofilled composite restorations and two indirect composite inlays after five years, using the modified USPHS criteria, also known as Ryge criteria, as the main evaluation tool.

MATERIALS AND METHODS

Patient Selection

With approval from the Ethics Committee of the School of Dentistry, Selcuk University (Konya, Turkey), young adult patients were selected from a pool of candidates that included routine polyclinic patients of the dental school clinic, as well as volunteers from staff and students and their families. Written informed consent forms were obtained from all patients at the start of this research study.

Each patient required two Class I or II cavities to be restored with a dental composite. The randomizations were performed by noting each tooth to be restored (Fédération Dentaire Internationale [FDI] two-digit code) on one form and the type of restorative system on a second. First, a tooth number was drawn blindly. Subsequently, a restorative system was allocated to this tooth by blind drawing. The clinical procedures of cavity preparation and restoration placement were performed by one calibrated dentist from the Department of Operative Dentistry. Data presented in this report were derived from the Class I and II resin-based composite restorations placed over a period of one year (2005–2006). Extremely large restorations (eg, a faciolingual occlusal isthmus that was more than two-thirds of the distance between facial and lingual cusp tips) were avoided. All restorations included for evaluation in this study had all-enamel margins, were in occlusion at baseline, and had no pulp exposure at placement.

In 54 patients, 22 men and 32 women with a mean age of 23 years (range, 20–28 years), a total of 108 Class I and Class II direct composite resin restorations and indirect composite resin inlays were placed. The evaluated restorations were distributed as follows: 45 first molars and 21 second molars in the lower arch; and 31 first molars and 11 second molars in the upper arch. Their distribution in terms of location and cavity type are summarized in Table 1. All teeth were in occlusion and had at least one proximal contact with an adjacent tooth.

Restorative Materials

Three nanofilled composite restorative systems (Filtek Supreme XT [FS], 3M ESPE, St. Paul, MN, USA; Tetric EvoCeram [TEC], Ivoclar Vivadent, Schaan, Liechtenstein; AELITE Aesthetic [AA], Bisco, Schaumburg, IL, USA) and two indirect inlay restorative systems (Estenia [E], Kuraray,Tokyo, Japan; Tescera ATL [TATL], Bisco, Schaumburg, IL, USA) were used in this study. Their compositions are summarized in Table 2.

Clinical Procedure for Indirect Composite Inlays

All cavities were prepared according to the common principles for adhesive inlays. To achieve convergence angles between opposing walls at an estimated 10°-12°, cavities were prepared with slightly tapered 80-μm–grit diamond burs and finished with 25-μm–grit diamond burs (KG Sorensen, Brazil) under water cooling. Care was taken to minimize increases

Table 1: *Distribution of Restorations (Location of Restoration) and Cavity Type*

	FS	TEC	AE	E	TATL	Total
Upper 1st molar	8	4	10	1	8	31
Upper 2nd molar	3	3	2	1	—	11
Lower 1st molar	7	11	4	12	11	45
Lower 2nd molar	4	5	4	7	1	21
Total	22	23	22	21	20	108
Class I	12	14	15	10	6	57
Class II	10	9	7	11	14	51
Total	22	23	22	21	20	108

Abbreviations: AE, AELITE Aesthetic; E, Estenia; FS, Filtek SupremeXT; TATL, Tescera ATL; TEC, Tetric Evo Ceram.

in cavity extension. The cavities were prepared with rounded inner line angles and to a depth that allowed for at least 2 mm of resin material at the occlusal contact area. All undercuts were eliminated.

Before placement of an inlay liner, each tooth was isolated with cotton rolls and a saliva suction device. In most cases, a thin layer of calcium hydroxide liner (Life, KerrHawe, Switzerland) was placed at the pulpal and axial walls.[20] Then, a light-polymerized glass ionomer cement base (Fuji II LC, GC, USA) was placed to eliminate undercuts in deep areas of the cavities and to replace lost dentin. The location of cervical margins above or below the cementoenamel junction was documented after preparation. Complete arch impressions were taken with a C-silicone impression material (Zetaplus; Zhermack, Italy). Provisional restorations were placed with a eugenol-free, light-curing temporary restorative material (Systemp inlay; Ivoclar Vivadent). One laboratory technician from the School of Dentistry prepared all the inlays following the manufacturers' instructions.

The E inlays were built up in layers of 2.5 mm, and each layer was polymerized from the occlusal direction for 120–180 seconds with a curing unit (Hilux Expert; Benlioğlu Dental, Turkey). Light output, which did not fall below 600 mW/cm^2, was measured using a handheld curing radiometer (Demetron, Danbury, CT, USA). After the composite inlays were removed from the stone model, they were postcured in a light oven (CS-110 Light and Heat Curing System; Kuraray) for 180 seconds and then in a heat oven for 10 minutes at 114°C in order to improve the physical properties. The polymerization unit provided for TATL inlays (Tescera ATL Processing Unit; Bisco) comprised two specialized cups (one for pressure/light and one for water/

Table 2: *Composition of Direct Composite and Indirect Inlay Systems*

Composite Materials	Organic Matrix	Inorganic Filler	% (by Weight)	% (by Volume)	Type of Composite
FS XT	TEGDMA, Bis-GMA, UDMA, Bis-EMA	Zirconia-silica (0.6-1.4 μm), silica (5-20 nm)	78.5	59.5	Nanohybrid (direct)
TEC	Bis-GMA, UDMA, DDDMA	Barium glass filler, ytterbium trifluoride, mixed oxide, and prepolymers (40–550 nm)	82	61	Nanohybrid (direct)
AA	EBis-GMA, Bis-GMA	Glass filler amorphous silica	73	54	Reinforced nanofill (direct)
TATL	EBis-GMA, UDMA	Glass filler amorphous silica	20–60; 1	0–40	Microhybrid (indirect)
E	UDMA, hydrophobic aromatic dimethacrylate, hydrophobic aliphatic dimethacrylate	Surface-treated alumina microfiller, silanated glass filler, silanated glass ceramics	92	82	Hybrid-ceramic (indirect)

Abbreviations: AE, AELITE Aesthetic; Bis-EMA, bisphenol A ethyleneglycol dimethacrylate; Bis-GMA, bisphenol A glycidyl dimethacrylate; DDDMA, decandiol dimethacrylate; E, Estenia; EBis-GMA, ethoxylated bisphenol A glycidyl dimethacrylate; FS XT, Filtek SupremeXT; TATL, Tescera ATL; TEC, Tetric Evo Ceram; TEGDMA, tetraethyleneglycol dimethacrylate; UDMA, urethane dimethacrylate.

pressure/light/heat). TATL inlays were built up in one increment and polymerized on the stone model in the light polymerization cup for five minutes. The inlays were then removed from the stone model, and composite inlays were postcured in the heat cup submerged in water at a temperature of 120°C and under a pressure of six bar.

The processed inlays were adjusted as needed and seated on the master model, and they were then polished with a silicone polisher, brushes, and polishing paste. After a clinical try-in, the inner surfaces of the inlays were etched with 37% phosphoric acid. All inlays were definitively inserted within one week after the impressions were made. The bonding of all restorations was performed in a dry working field using cotton rolls and a saliva suction device but without a rubber dam. The E inlays were cemented with a dual-cure resin cement, Panavia F (Kuraray); similarly, the TATL inlays were also cemented with a dual-cure resin cement, Duo-Link (Bisco). The inserted restorations were finished with 40-μm–grit and 15-μm–grit diamond burs (Jota AG, Switzerland), polishing disks and strips (Sof-Lex; 3M ESPE), and a composite polishing kit (Enhance; Dentsply, Milford, CT, USA).

Clinical Procedure for Direct Composite Restorations

First, the color of the tooth that needed treatment was determined using a color key. If necessary, local anesthesia was administered to prevent patient discomfort during the restorative procedure. The teeth to be restored were cleaned with pumice-water slurry in a rubber cup to remove salivary pellicle and any remaining dental plaque. The cavity was opened (or the existing restoration was removed) using a pear-shaped diamond bur (Jota AG) on a high-speed air turbine. Caries was removed with low-speed metal burs (Meisinger, Germany) and hand instruments, leaving discolored but hard dentin at the cavity floor. Cavities were prepared according to the principles of minimally invasive dentistry.

Tooth isolation by means of cotton rolls and a saliva suction device was used for each patient. All cavities were restored using a sectional metal matrix (Contact Matrix; Palodent, USA) that was fixed with a ring and wooden wedges (Kerr) and inserted with firm pressure. For all the direct composites, the bonding procedure began with the application of a freshly mixed self-etch primer (Clearfil SE Primer; Kuraray) to the cavity walls for 20 seconds, and the area was then dried with gentle air-drying for 5 seconds. Bonding agent (Clearfil SE Bond; Kuraray) was applied with a microbrush and polymerized for 10 seconds. After application of the self-etching primer and bonding agent, the cavities were filled incrementally with facially and lingually inclined mesiodistal layers no more than 2 mm thick. Between each increment (maximally at 2 mm), polymerization was performed with a halogen light-curing unit (Hilux Expert, Benlioğlu Dental; tip diameter: 8 mm) for 20 seconds (TEC, AA, FS) or 40 seconds (FS dentin shade). Curing light was directed perpendicular to the occlusal surface. Light output, which did not fall below 600 mW/cm^2, was measured using a handheld curing radiometer (Demetron).

After removing the matrix holder and wedges, the gingival areas were cured for 20 seconds from the facial and lingual directions. The occlusion and articulation were checked and adjusted, and then the direct composite restorations were finished with fine-grit diamond instruments (Jota AG), Sof-Lex disks (3M ESPE), rubber polishing instruments, and a composite polishing kit (Enhance; Dentsply). All finishing procedures were performed under water cooling. In most cases, color photographs of marked occlusal contact points were taken.

Clinical Evaluation

Restorations were rated independently with a mirror and probe by two experienced dentists (NU, NC) who were not involved with the insertion of the indirect composite inlays and the direct composite restorations. Restorations were assessed directly after the final finishing (baseline evaluation, one week after treatment) and at one and five years using the modified USPHS criteria (Table 3). This clinical assessment method resulted in ordinally structured data for the outcome variables (*Alpha* = *excellent result*; *Bravo* = *acceptable result*; *Charlie* = *unacceptable, replacement of the restoration necessary*).[5]

Statistical Analysis

The ratings for restorations at baseline and follow-up examinations were analyzed using the Fisher exact test and McNemar χ^2 test for each category. The standard value considered to demonstrate statistically significant differences was set at $p \leq 0.05$.

RESULTS

At one- and five-year recalls, all of the 54 patients were available for evaluation. At baseline, 4% (five teeth) of the restorations presented postoperative sensitivity; however, only one (a member of the E

Table 3: *Modified USPHS Criteria*

Surface texture	*Alpha* (A)	Surface is not rough
	Bravo (B)	Surface is slightly rough
	Charlie (C)	Surface is highly rough
Marginal integrity	A	Absence of discrepancy at probing
	B	Presence of discrepancy at probing, without dentin exposure
	C	Probe penetrates in the discrepancy at probing, with dentin exposure
Marginal discoloration	A	Absence of marginal discoloration
	B	Presence of marginal discoloration, limited and not extended
	C	Evident marginal discoloration, penetrated toward the pulp chamber
Gingival adaptation	A	Gingival tissues are perfect
	B	Gingival tissues are slightly hyperemic
	C	Gingival tissues are inflammation
Postoperative sensitivity	A	Absence of the dentinal hypersensitivity
	B	Presence of mild and transient hypersensitivity
	C	Presence of strong and intolerable hypersensitivity
Color match	A	Restoration is perfectly matched for color shade
	B	Restoration is not perfectly matched for color shade
	C	Restoration is unacceptable for color shade
Retention	A	Complete retention of the restoration
	B	Mobilization of the restoration, still present
	C	Loss of the restoration
Secondary caries	A	No evidence of caries contiguous with the margin of the restoration and at radiograph
	C	Caries is evident contiguous with the margin of the restoration and at radiograph

group) required canal treatment and replacement after two years. The restorations were evaluated for retention and gingival adaptation, and 100% *Alpha* ratings were obtained for both restorative systems at one and five years. Only one tooth (a member of the TEC group) required replacement after three years due to secondary caries. Color match for TATL and AA were scored as 95% at five years, and the rates for the other systems were 100% *Alpha*. Marginal integrity was scored as *Alpha* in 82% of AA

Table 4: *Results (%) of the Clinical Evaluation of Restorations*

Evaluation criteria	Filtek Supreme XT				Tetric Evo Ceram				Aelite Aesthetic				Estenia				Tescera ATL			
	Baseline		Five year		Baseline		Five year		Baseline		Five year		Baseline		Five year		Baseline		Five year	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Surface texture	100	0	**82**	**18**	100	0	95	5	100	0	**82**	**18**	100	0	95	5	100	0	95	5
Marginal integrity	100	0	100	0	100	0	95	5	100	0	**82**	**18**	100	0	**84**	**16**	100	0	90	10
Marginal discoloration	100	0	**87**	**13**	100	0	95	5	100	0	**64**	**36**	100	0	**73**	**27**	100	0	**70**	**30**
Gingival adaptation	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0
Postoperative sensitivity	100	0	100	0	95	5	100	0	100	0	100	0	90	10	100	0	95	5	100	0
Color match	100	0	100	0	100	0	100	0	100	0	95	5	100	0	100	0	100	0	95	5
Retention	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0
Secondary caries	100	0	100	0	100	0	96	4	100	0	100	0	100	0	100	0	100	0	100	0

Abbreviations: A, Alpha; B, Bravo.

restorations, 84% of E restorations, 90% of TATL restorations, 95% of TEC restorations, and 100% of FS restorations. After five years, the surface texture for 82% of FS and AA restorations was scored as *Alpha*, and 95% of E, TEC, and TATL restorations was scored as *Alpha*. The marginal discoloration for 64% of the AA restorations was scored as *Alpha*; for TATL, 70%; for E, 73%; for FS, 87%; and for TEC, 95%. Nonetheless, for the evaluation criteria (presented in Table 4), numerical—but not statistically significant—differences were noted. There was a statistically significant difference between AA and TEC but only for marginal discoloration criteria. None of the restorative systems received a *Charlie* rating for any of the evaluation criteria. Moreover, all the restorations were rated as clinically acceptable in all of the evaluated criteria for all of the materials.

DISCUSSION

In the present study, new brands of direct and indirect composites were evaluated using clinical criteria that have been defined in previous studies.[21–23] In accordance with the American Dental Association's guidelines for testing new materials,[24] the sample size used in this study was 54 patients and the following steps were taken to comply with the guidelines: placing an appropriate number of restorations (average 20 per material), limiting the distribution of restorations (maximum of two pairs in the same patient), and ensuring a ratio of 1:2 for Class I to Class II restorations.

At all the evaluation periods in this study, the recall rate was 100%. Indeed, availability was still expected to be high at other prolonged evaluation periods because a majority of the subjects in this study were young adult patients with a mean age of 23 years (range, 20–28 years), and they were selected among the volunteers from staff and dental students and their families. In the present study, the restorations had high success rates of 97.5% and 98.4% after five years, which are contrary to the results of some studies.[25,26] The clinical efficacy thus reflects the survival rate of the restorations carried out by excellent clinicians under optimal conditions and placed on trial patients specifically selected for good compliance. Moreover, the use of such an age range could facilitate better performance of posterior restorations in clinical evaluations due to younger patients' better occlusal harmony.

The isolation of the restoration site can be carried out using different methods. In some clinical studies on posterior composites, a rubber dam was used to isolate the teeth,[27-29] whereas Turkun,[30] Köhler and others,[25] and Pallesen and Qvist[31] opted for cotton rolls and a saliva suction device. Raskin and others,[32] in a 10-year evaluation of posterior composites, did not observe significant differences between these two isolation methods.

According to Mitra and others,[13] the nanofilled composite was shown to have equivalent—if not superior—mechanical properties as the hybrid composite; the nanocomposite exhibited high translucency, high polish, and polish retention similar to the properties of microfilled composite. In other words, these composites might promote a satisfactory clinical performance in posterior teeth. Additionally, nanofilled composites could also double as satisfactory materials for restorations in anterior teeth. Despite the fact that nanocomposites and nanofilled and nanohybrid composite resins have been used for posterior restorations for several years, reports on their success in the literature are limited.[22,33-37] The rehabilitation of decayed or fractured posterior teeth using an inlay/onlay technique was introduced to overcome some of the problems associated with direct restorative techniques, including inadequate proximal or occlusal morphology, insufficient wear resistance or mechanical properties of directly placed filling materials, and the restoration of severely destroyed teeth.[38] Moreover, laboratory-processed indirect composite resin systems are an attractive esthetic alternative for intracoronal posterior restorations.[14,15] A major point of early failure with composite resins is a loss of material due to wear. However, the early wear behaviors of the composite resins used in this study have recently been reported.[39] The average wear of the composites were within the established guidelines according to the American Dental Association requirements. For that reason, we did not mention wear criteria in this study.

In their four-year clinical study, Geurtsen and Scholer[26] claimed that the most important problem in posterior composite restorations is marginal discoloration. Marginal discoloration is classified based on the penetration of dye into the pulp. In our study, statistical analysis showed that there were significant differences in marginal discoloration among the AA and TEC restorative materials. Of the direct TEC restorations, 95% received *Alpha* ratings for marginal discoloration at all the evaluation periods. In a study by Türkün and Çelik,[40] a two-year clinical evaluation of FS restorations yielded similar marginal discoloration outcomes.

After five years of clinical service, more indirect composite inlays received *Alpha* ratings for surface texture compared with the direct composite restorations. However, in a study by Loguercio and others,[41] the nanofilled and microfilled composites showed the best surface appearance after 12 months. In the present study, better anatomic form and surface texture results, which were obtained for the indirect composite inlays, could be attributed to higher wear resistance, even though these differences were not statistically significant. The latter improvement was realized because the indirect composite inlays were postcured in a heat oven for 10 minutes. On the other hand, in a two-year clinical evaluation of direct and indirect composite restorations in posterior teeth by Scheibenbogen-Fuchsbrunner and others,[9] no significant differences between these two different types of posterior composite systems were observed. According to the results of this study, both direct and indirect composite resin restorations demonstrated excellent clinical performance, whereby no restorations were rated unacceptable in any aspect of the evaluation. Similarly, in a 12-month evaluation of two posterior composite restorative systems by Neto and others,[21] 94.1%-100% *Alpha* ratings were obtained for the evaluated criteria, according to the modified USPHS system. In another two-year clinical evaluation by Türkün and Aktener,[42] all of the evaluated posterior composite restorations were rated as excellent. In a study by Efes and others,[43] all the restorative materials showed only minor changes, and no statistically significant differences in their performance were detected between baseline and the follow-up evaluation at 12 months. In particular, the performance exhibited by nanofilled composite resins after one year was similar to the performance of the packable and microhybrid composite resins.

Longevity of dental restorations is dependent upon many factors that are patient-, material-, and dentist-related.[44] According to the results of the study of Kubo and others,[17] at least 60% of resin composites placed in adults are likely to survive 10 years, regardless of the cavity type. In addition, factors related to the patient, operator, material, and cavity may have an interactive influence on the longevity of resin composite restorations.[17] The results of a comprehensive meta-analysis on posterior restorations demonstrate annual failure rates for posterior composite resin inlays and onlays that range from 0%-10%, with a mean value of 2.9% (median, 2.3%); for alternative restorations, the mean annual failure rates were reported to be 3% for amalgam, 2.2% for direct composite resin fillings, 1.9% for ceramic inlays, and 1.4% for gold inlays.[7] For the first marketed nanofilled resin composite, Filtek Supreme, an acceptable 1- to 3-year performance has been shown.[45,46] Recently published short-term clinical evaluations of different nanohybrid resin composites have reported annual failure rates between 0% and 2.4%.[22,35-37,47] In a study by van Dijken and Pallesen,[48] the annual failure rate of nanohybrid composite was 1.9%, and the fracture of the restoration was the main reason for failure. On the other hand, in a study by Huth and others,[49] clinical assessments of Artglass and Charisma composite resin inlays revealed annual failure rates of 3.2% and 5.9%, respectively. Within the limitations of this study, indirect composite inlays are a competitive restorative procedure in stress-bearing preparations.[49] In another clinical evaluation by Signore and others,[50] the six-year symptom-free survival rate of bonded indirect resin composite onlays was 93.02%. There are only a few clinical studies in the literature that compare direct and indirect composite restorations. According to these studies, direct restorations and indirect inlays in posterior teeth provide satisfactory clinical performance, and comparisons among them indicate little or no differences.[2,9,18,51] Within the limits of the present study, indirect composite resin inlays showed a success rate of 97.5% and direct composite resins showed a success rate of 98.4% after five years, consistent with the results of the previous studies.

In the present five-year clinical study, both the direct and indirect composite restorations were rated as clinically acceptable according to the evaluation criteria used, and there were no statistically significant differences in the performance of the tested materials. This lack of significant differences could be due to the multiple similarities in the composites used in this study in terms of chemical composition and high filler content (Table 2). However, differences might emerge over longer periods of use. Nevertheless, better clinical performance might be obtained using E and TATL because they are indirect composite resins that are specifically designed for restoring posterior teeth. Furthermore, indirect composites, when tempered with heat and light, could exhibit an enhanced degree of curing, thereby leading to improved physical properties.

CONCLUSION

The results of the present study revealed comparable clinical performance in the five composites evaluated. After five years, the clinical performances of FS, TEC, and AA showed minor changes compared with baseline. Under controlled clinical conditions, after five years, indirect composite resin inlays and direct resin restorations exhibited annual failure rates of 2.5% and 1.6%, respectively, which are within the range of published data. Therefore, the investigated materials all displayed acceptable clinical performance, and no significant differences were found among them. Because the clinical performance of the posterior composite restorations was evaluated as acceptable after five-year use, the tested composites could be indicated for conservative restorations in posterior teeth.

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.

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