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Clinical evaluation of in-office tooth bleaching effects on three contemporary composite resins

Abstract

Objectives: To evaluate and compare the clinical performance of three contemporary nano-composite resin restorations as anterior restorations in class IV cavities in maxillary anterior teeth over one year follow-up period after the bleaching.

Materials and methods: A total of 30 restorations (twelve subjects), 18-38 year olds with class IV carious upper anterior teeth were included, divided into three groups. Each group (n=10 restorations) was randomly restored with the same restoration material type; Beautifil II nano hybrid composite resin (Shofu Dental Corporation, USA), IPS Empress Direct nano hybrid composite resin (Ivoclar Vivadent, USA), and the nano ceramic micro hybrid composite resin Ceram-x-mono (DeTrey, Dentsply, Germany). They were restored according to the manufacturers' instructions. A clinical evaluation was conducted before bleaching (baseline) and two days, 3 months, 6 months, and one year after bleaching for modified Ryge criteria. The A and B scores were considered clinically acceptable while C and D scores were considered clinically unacceptable. The data were subjected to statistical analysis using Chi-squared test (X^2) and ANOVA.

Results: All materials were considered clinically acceptable as anterior dental restoration. The survival rate was 100% between the Ceram-x-mono and Beautifil II materials in the clinical performance after 6 months and one year (P=0.00), whereas ISP Empress Direct was inferior in anatomical form, color match, and marginal discoloration integrity.

Conclusion: It was concluded that a three-tested dental restoration is considered clinically acceptable as an anterior restoration. Therefore, the use and the long-term effects of bleaching on ISP Empress Direct should be carefully considered.

Keywords: beautifil ii, isp empress direct, ceram.x.mono composite resin, modified ryge criteria, in-office bleaching

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Introduction

Since the invention of dental resin composites in 1962 by Bowen et al.,[1] there has been great progress in research conducted to improve the mechanical, physical, and optical properties of these materials. Dental resin composites have the ability to be retained on tooth structure via micromechanical retention. Restoring caries and correcting defects with reliable esthetics are easy to handle and cost effective. To overcome the problems of polymerization shrinkage and low abrasive wear resistance, several studies were conducted to modify the inorganic fillers in order to increase optical, physical, and mechanical strength, which will improve the abrasive wear resistance that has an effect on the long-term performance and esthetics of resin composites. Traditional composites contained silicate glass fillers within acrylic monomer. Ceramic fillers such as alumina, Leucite, mica-aptite, and zirconia have high flexural strength and were introduced to improve strength.[2] The optical properties and structural reliability of ceramics have been used to reinforce the formula of resin composites.[3] The excellent physical characteristics of this category of restorative materials have been described by the manufacturers as easy to handle, improved physical and mechanical properties, biocompatibility, and radiopacity.[4] In the study by Luo et al., they found no post-operative sensitivity was reported in any restored tooth at each patient assessment. Only a slight color change with some surface staining was noted. Slight marginal changes were observed in 12 of 53 restorations seen as step irregularities when a sharp explorer was drawn across the tooth from the enamel toward the restoration interface. Utilizing USPHS evaluation criteria, the clinical performance of each (FL-Bond II & Beautifil II) posterior fluoride releasing system was clinically acceptable at 18 months.[5] In another study, they evaluated the micro leakage of a giomer resin bonded with total-etch and self-etch adhesive systems after exposure to hydrogen peroxide. This revealed a statistically significant difference between subgroups at the occlusal level ($p<0.0001$). Group IA yielded the most microleakage. No statistically significant difference was reported at the gingival level. Microleakage was affected by hydrogen peroxide exposure only at the enamel cavosurface margin when a self-etching primer adhesive system was used.[6] Dental practitioners need better scientific data from clinical studies to determine the in-office bleaching effects on the use of nanohybrid and nano ceramic micro hybrid composite resin materials in anterior teeth. Laboratory investigations are crucial for an early assessment of a dental restorative.[7] but only a clinical study can take into account all the potential variables which vary from patient to patient,[8] influencing the overall performance of a restorative.[9] These variables include mastication forces, abrasive foods, chemically active foods and fluids, temperature fluctuations, humidity variation, bacterial byproducts, and salivary enzymes.[10–12] However, only a few clinical studies concerning the performance of

nanohybrid and nano ceramic micro hybrid composite resin materials have been published.[13–16] The present study is aimed at evaluating and comparing the one year after bleaching clinical performance of nanohybrid and nano ceramic micro hybrid composite resin restorations of class IV cavities made in upper anterior teeth.

Materials and methods

The research proposal and study design was approved by the esthetical committee of research and IRB of Beirut Arab University. A total of 15 subjects, 18-45 year olds with one or more defective class IV restoration or class IV caries including the labial surface of maxillary anterior teeth were included in the study. Institutional Review Board (IRB) consent forms were obtained from the patients. The subjects were selected from the outpatient clinic of the Faculty of Dentistry at the Beirut Arab University according to the following criteria, see Table 1. The preoperative clinical evaluation included complete medical and dental histories, anterior maxillary per apical radiograph, and an assessment of pulp vitality and tooth sensitivity or history of pain. The subject was informed about all the details of this investigation and they signed IRB consent forms to participate in this study. All 36 restorations (15 subjects) were evaluated at before bleaching (baseline) after one week of restorations prior to bleaching treatment and two days, three months, six months, and one year after bleaching. Evaluations were performed under the conventional light of the dental unit; the subjects were seated in the dental chair, using a No.5 front-surfaced dental mirror and explorer. The modified Ryge criteria was used during clinical evaluation to assess for retention, color match, marginal discoloration, caries, anatomic form, marginal adaptation, and surface roughness (Table 2). From the 36 restorations (15 subjects), only 30 restorations (12 subjects) remained two days after bleaching was performed. The twelve subjects consisted of nine males and three females between the ages of 28-30 years old. The 6 restorations (three subjects) were excluded from the study because they could not attend the follow-up session at the clinic (the two days evaluation after the bleaching): One patient with Beautifil II, one patient with Ceram.x.mono, and one patient with ISP Empress Direct restorations (Table 3). The minimum specimen size required was ten restorations in each group. Each group contain 10 restorations (n=4 subjects) consisting of three subjects were with three upper anterior teeth defective class IV restoration or class IV caries and one subject was with one upper anterior teeth lesion, which were restored with the same restoration material type before one week to the bleaching, and divided into three groups according to the type of restorations materials. Three groups of resin composite materials were used in this study: Beautifil II; Bisphenylglycidyl Dimethacrylate (Bis-GMA), 7.5% Triethylenglycol Dimethacrylate (TEGDMA), 5% Aluminofluoro, 70% Al2O3 (borosilicate glass). DL-Camphorquinone, (Shofu Dental Corporation, USA). ISP Empress Direct; Paste of Dimethacrylates, copolymer 20-21%wt, barpum glass 77.5-79%wt, ytterbium trifluoride (550nm), Initiators, stabilizers and pigments, (Ivoclar Vivadent, USA). Ceram.x.mono; methacrylate modified polysiloxane, dimethacrylate resin, Ba-Al-borosilicate glass 70%, pyrogenic SiO2 57%, camphorquinone, ethyl-4-diemthylamino benzoate, UV stabilizer, butylated hydroxy toluene, (DeTrey, Dentsply, Germany). The conservative cavity preparations were set to be conservative in outline, just to include the prepared defective area. Thirty-six conservative Class IV cavities were prepared just to include the defective area using No.330 carbide burs (SS White), and using 80 µm diamond burs (Intensiv; Lugano, Switzerland) under continuous water cooling. The entire cavity was then finished using 25 µm finishing diamond burs (Intensiv); the Class IV preparation with a marginal bevel in enamel was prepared in all teeth. Two teeth had deep cavities, the deepest part of cavity was covered with a thin layer of calcium, and then a rubber dam was put in place. Each cavity was etched with 37% Phosphoric acid (Dentsply Detrey) for 15 sec, rinsed with a water spray for 20 sec and blot dried. Prime & Bond NT (Dentsply Detrey) was applied and left undisturbed for 20 sec, air-thinned for 5 sec, and light-cured for 40 sec. Shade A1 was selected for all the restorations to overcome the teeth color changes after bleaching; the cavity was etched with 37% phosphoric acid (Dentsply Detrey) for 15 sec and then rinsed with water for 20 sec, and blot dried. Prime & Bond NT (Dentsply Detrey) was applied and left undisturbed for 20 sec, air thinned for 5 sec, and light cured for 40 sec using a light curing unit (GNATUS, Fotopolimerizador optilight plus, Brazil) with an intensity of 350 mW/cm^2. Then the cavities were restored incrementally using the three-mentioned restorative materials and were placed according to the manufacturer's instructions under complete rubber dam isolation. The finishing and polishing of the restoration was done at the same visit using medium, fine, and superfine polishing discs (Sof-Lex system; 3M ESPE) with a slow-speed hand piece rotating in one direction using a three-step technique. The restored teeth were checked for high points with articulating paper. The baseline measurements for all the restorations were one week after the placement of restorations and prior to the bleaching treatment (Table 3). To eliminate bias, assessments were performed in a blinded design where the examiner and patients had no preliminary information about the type of restorations. Evaluations were performed under the conventional light of the dental unit with the subject seated in the dental chair, using a No.5 front-surfaced dental mirror and explorer. The patients were recalled at different intervals; prior to the in-office bleaching, then two days, three months, six months, and one year after bleaching for evaluation of the efficacy of restoration by using United States Public Health Services (USPHS) Ryge criteria, which will determine the status of: Retention, color match, marginal discoloration, presence of recurrent caries, anatomic form, marginal adaptation, and surface texture of the evaluation form (Table 2). Clinical criteria data were analyzed using SPSS version 20 software. Chi-square (X^2) was used for the qualitative data test to investigate the criteria. A least significant differences (LSD) test for repeated measures and an analysis of variance was performed to analyze and compare between the three restoration types.

Table 1 The inclusion and exclusion criteria for subjects included to participate in this study Inclusion criteria exclusion criteria

•	Inclusion Criteria	Exclusion Criteria
•	1. Candidates must be between 18-45 years of age.	1. Candidates who used bleaching products in the past three years.
•	2. Candidates must have one or more Class IV carious or defective anterior teeth that require restoration.	2. Any cavity having the gingival wall surpassing cemento-enamel junction to ensure all cavity walls was on enamel.
•	3. The teeth must be vital, free of visible cracks and have no signs of preoperative sensitivity.	3. Candidates who are smokers.
•	4. Candidates teeth baseline shade is A3.	4. Candidates with a history of hydrogen-peroxide product sensitivity, periodontal inflammation, chronic periodontitis, or periapical pathosis.

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Table Continued...

• Inclusion Criteria	Exclusion Criteria
	5. Candidates having a severe medical complication that interfere with the study (liver diseases, peroxide products sensitivity, etc.).
	6. Candidates having systemic diseases or taking medication that cause tooth discoloration or Xerostomia.
	7. Candidates with severe bruxism, tooth clenching, or unstable occlusion.

Table 2 Clinical evaluation according to Clinical criteria according to Modified Ryge criteria of the restoration

Clinical Criteria	Test Procedure	Ryge Criteria Score
Retention	Visual inspection with explorer and mirror if needed	A: No loss of restorative material B: loss of restorative material
Color match	Visual inspection with mirror at 18 inches	A: the restoration matches the adjacent tooth structure in color and translucency. B: light mismatch in color and translucency between the restoration and the adjacent tooth structure C: mismatch in color and translucency is outside the acceptable range of tooth color and translucency.
Marginal discoloration	Visual inspection with mirror at 18 inches	A: no discoloration anywhere along the margin between the restoration and adjacent tooth. B: slight discoloration along the margin between the restoration and adjacent tooth away C: discoloration penetrated along the margin between the restoration material in a pulpal direction
Secondary caries	Visual inspection with explorer and mirror if needed	A: no evidence of caries B: slight discoloration along the margin between the restoration and adjacent tooth away. C: discoloration penetrated along the margin between the restoration material in a pulpal direction
Anatomical form	Visual inspection with explorer and mirror if needed	A: the restoration is continuous with existing anatomical form B: the restoration is discontinuous with existing anatomical form. However, the material is not sufficient to expose the dentine or base. C: sufficient material lost to expose the dentine or base.
Marginal integrity	Visual inspection with explorer and mirror if needed	A: no visual evidence of a crevice along the margin. B: visual evidence of a crevice along the margin into which the explorer will penetrate. C: the dentin or base exposed. D: restoration is fractured, mobile, or missing.
Surface texture	Visual inspection with explorer and mirror if needed	A: the restoration surface is as smooth as surrounding enamel. B: the restoration surface is rougher than surrounding enamel.

Table 3 Number of restorations evaluated at each recall examination

Materials Groups	Before Bleaching	After Two Days of Bleaching	After 3 Months of Bleaching	After 6 Months of Bleaching	After One Year of Bleaching
B	12	10	10	10	10
E	12	10	10	10	10
C	12	10	10	10	10

B: Beautiful II group, E: ISP Empress Direct group, C: Ceram.x.mono group.

C: there is a crevice and fracture on the surface of restoration

Clinical criteria score : A Alpha, B Bravo, C Charlie, D Delta

Results

From a total of 36 restorations placed (15 subjects) at two days after bleaching only 12 subjects (30 restorations placed) were performed. They were assessed clinically for the USPHS modified Ryge criteria before bleaching (baseline) and two days, 3 months, 6 months and at the end of one year (Table 3). The results shows that at two days after bleaching, two restorations from each type of composite resin restoration dropped out due to the patients not returning for examination. The number of restorations evaluated at each recall and survival rate was 30 restorations (100%) for all types at the one-year recall examination. The clinical criteria of the three composites resin restorations were evaluated at each recall examination: Before bleaching, two days after bleaching, and three months, six months, and one year after bleaching. All the restorations were clinically evaluated using modified Ryge criteria. Score A (Alpha) indicates the clinically ideal restoration. Score B (Bravo) is a clinically acceptable situation except for retention and secondary caries. Score C (Charlie) indicates clinically unacceptable restorations that must be replaced. The statistical analysis results that show all the subjects who were available for restoration evaluation at the one year after bleaching recalls. Anatomic form, marginal adaptation, marginal discoloration, and color match showed significant differences (Table 2). Highly significant differences were found among the Beautifil II, ISP Empress Direct, and Ceram.x.mono groups for color match ($P<0.01$). ISP Empress Direct was significantly lower than Ceram.x.mono and Beautifil II at all the follow-up sessions after the bleaching. Also regarding marginal discoloration, ISP Empress Direct was highly significantly lower than the Ceram.x.mono and Beautifil II groups at six months and one year after bleaching ($P<0.01$). Time had a significant effect on the Beautifil II, ISP Empress Direct, and Ceram.x.mono groups for all the parameters except retention, recurrent caries, and surface texture of all three tested groups, and marginal discoloration and marginal adaptation of both the Beautifil II and Ceram.x.mono groups.

Retention

The bleaching and time had no significant effect on the retention parameter. All specimens achieved an Alfa score at all the time intervals (Table 4).

Table 4 Results of the Modified Ryge Criteria as percentage difference for all the groups at all time period intervals. [P_1 comparison between the three groups types (Bea, IPS and Cer) at the same time period of follow up. P_2 comparison between the same group types in the different time periods in relation to baseline

Criteria	Score	T_0				T_1				T_2			
		Bea	IPS	Cer	P_1	Bea	IPS	Cer	P_1	Bea	IPS	Cer	P_1
Retention	A	100%	100%	100%	P>0.05	100%	100%	100%	P>0.05	100%	100%	100%	P>0.05
	B	0	0	0	P>0.05	0	0	0	P>0.05	0	0	0	P>0.05
	C	0	0	0	P>0.05	0	0	0	P>0.05	0	0	0	P>0.05
	P_2	P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05	
	Score	T_3				T_4							
		Bea	IPS	Cer	P_1	Bea	IPS	Cer	P_1				
Retention	A	100%	100%	100%	P>0.05	100%	100%	100%	P>0.05				
	B	0	0	0	P>0.05	0	0	0	P>0.05				
	C	0	0	0	P>0.05	0	0	0	P>0.05				
	P_2	P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05					
	Score	T_0				T_1				T_2			
		Bea	IPS	Cer	P_1	Bea	IPS	Cer	P_1	Bea	IPS	Cer	P_1
Color Match	A	0	0	0	P>0.05	100%	40%	100%	P=0.01**	90%	40%	100%	P<0.01**
	B	0	0	0	P>0.05	0	60%	0	P=0.05*	10%	60%	0	P<0.01**
	C	100%	100%	100%	P>0.05	0	0	0	P>0.05	0	0	0	P>0.05
	P_2	P>0.05	P>0.05	P>0.05		P=0.01**	P=0.03*	P=0.01**		P=0.01**	P=0.03*	P=0.01**	

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Table continued...

Criteria	Score	T_0				T_1				T_2			
		Bea	**IPS**	**Cer**	P_1	**Bea**	**IPS**	**Cer**	P_1	**Bea**	**IPS**	**Cer**	P_1
Color Match	**Score**	**T3**				**T4**							
		Bea	**IPS**	**Cer**	P_1	**Bea**	**IPS**	**Cer**	P_1				
	A	90%	40%	90%	P<0.01**	90%	40%	90%	P<0.01**				
	B	10%	60%	10%	P<0.01**	10%	50%	10%	P<0.01**				
	C	0	0	0	P>0.05	0	10%	0	P>0.05				
	P_2	P<0.01**	P=0.03*	P<0.01**		P<0.01**	P=0.03*	P<0.01**					
Marginal Discoloration	**Score**	T_0				T_1				T_2			
		Bea.	**IPS**	**Cer.**	P_1	**Bea.**	**IPS**	**Cer.**	P_1	**Bea.**	**IPS**	**Cer.**	P_1
	A	100%	100%	100%	P>0.05	100%	100%	100%	P>0.05	100%	100%	100%	P>0.05
	B	0	0	0	P>0.05	0	0	0	P>0.05	0	0	0	P>0.05
	C	0	0	0	P>0.05	0	0	0	P>0.05	0	0	0	P>0.05
	P2	P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05	
Marginal Discoloration	**Score**	**T3**				**T4**							
		Bea	**IPS**	**Cer**	P_1	**Bea**	**IPS**	**Cer**	P_1				
	A	100%	90%	100%	P>0.05	100%	80%	100%	P<0.01**				
	B	0	10%	0	P>0.05	0	10%	0	P>0.05				
	C	0	0	0	P>0.05	0	10%	0	P>0.05				
	P2	P>0.05	P=0.305	P>0.05		P>0.05	P=0.048*	P>0.05					
Recurrent caries	**Score**	T_0				T_1				T_2			
		Bea	**IPS**	**Cer**	P_1	**Bea**	**IPS**	**Cer**	P_1	**Bea**	**IPS**	**Cer**	P_1
	A	100%	100%	100%	P>0.05	100%	100%	100%	P>0.05	100%	100%	100%	P>0.05
	B	0	0	0	P>0.05	0	0	0	P>0.05	0	0	0	P>0.05
	C	0	0	0	P>0.05	0	0	0	P>0.05	0	0	0	P>0.05
	P_2	P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05	
Anatomic Form	**Score**	T_3				T_4							
		Bea	**IPS**	**Cer**	P_1	**Bea**	**IPS**	**Cer**	P_1				
	A	100%	100%	100%	P>0.05	90%	90%	90%	P>0.05				
	B	0	0	0	P>0.05	10%	10%	10%	P>0.05				
	C	0	0	0	P>0.05				P>0.05				
	P_2	P>0.05	P>0.05	P>0.05		P=0.305	P=0.305	P=0.305					
Marginal Integrity	**Score**	T_0				T_1				T_2			
		Bea.	**IPS**	**Cer.**	P_1	**Bea.**	**IPS**	**Cer.**	P_1	**Bea.**	**IPS**	**Cer.**	P_1
	A	100%	100%	100%	P>0.05	100%	100%	100%	P>0.05	100%	100%	100%	P>0.05
	B	0	0	0	P>0.05	0	0	0	P>0.05	0	0	0	P>0.05
	C	0	0	0	P>0.05	0	0	0	P>0.05	0	0	0	P>0.05
	P_2	P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05	
Marginal Integrity	**Score**	T_3				T_4							
		Bea	**IPS**	**Cer**	P_1	**Bea**	**IPS**	**Cer**	P_1				
	A	100%	90%	100%	P=0.982	100%	90%	100%	P=0.982				
	B	0	10%	0	P=0.054	0	10%	0	P=0.054				
	C	0	0	0	P>0.05	0	0	0	P>0.05				
	P_2	P>0.05	P=0.305	P>0.05		P>0.05	P=0.305	P>0.05					

Table continued...

Criteria	Score	T_0				T_1				T_2			
		Bea	IPS	Cer	P_1	Bea	IPS	Cer	P_1	Bea	IPS	Cer	P_1
	Score	T_0				T_1				T_2			
		Bea	IPS	Cer	P_1	Bea	IPS	Cer	P_1	Bea	IPS	Cer	P_1
Surface Texture	A	100%	100%	100%	P>0.05	100%	100%	100%	P>0.05	100%	100%	100%	P>0.05
	B	0	0	0	P>0.05	0	0	0	P>0.05	0	0	0	P>0.05
	C	0	0	0	P>0.05	0	0	0	P>0.05	0	0	0	P>0.05
	P_2	P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05	
	Score	T_3				T_4							
		Bea	IPS	Cer	P_1	Bea	IPS	Cer	P_1				
Surface Texture	A	100%	100%	100%	P>0.05	100%	100%	100%	P>0.05				
	B	0	0	0	P>0.05	0	0	0	P>0.05				
	C	0	0	0	P>0.05	0	0	0	P>0.05				
	P_2	P>0.05	P>0.05	P>0.05		P>0.05	P>0.05	P>0.05					

* Significant difference at P< 0.05 level, ** High significant difference at P<0.01 level

Bea: Beautifil II group, IPS: IPS Empress Direct group, Cer: Ceram.x.mono group

T0: Before bleaching; T_1: Two-days after bleaching; T_2: Three-months after bleaching,

T_3: Six-months after bleaching; T_4: One-year after bleaching

* Significant difference at P< 0.05 level;** High significant difference at P<0.01 level

Color match

There were highly significant statistical differences in color match among the three composite resins ($p<0.01$). Time also had a highly significant statistical effect on color match ($p<0.01$). All the Ceram.x.mono specimens were able to maintain the matched color for 3 months after bleaching, while 10% of the specimens showed color mismatch six months and one year after bleaching; however, this color mismatch was clinically acceptable. Regarding Beautifil II, 90% of the specimens maintained color match at three months, six months, and one year after bleaching. Regarding ISP Empress Direct, 40% of the specimens maintained color match at two days, three months, six months, and one year after bleaching and only 10% of the specimens maintained a color mismatch which needed replacing at one year after bleaching (Table 4).

Marginal discoloration

There were highly significant statistical differences in marginal discoloration among the three composite resins ($p<0.01$). Time also had a significantly statistical effect on marginal discoloration ($p<0.01$). All the ISP Empress Direct specimens were able to maintain the marginal discoloration for three months after bleaching, while 10% of the specimens showed color mismatch at six months and one year after bleaching; however, this marginal discoloration was clinically acceptable. Regarding Beautifil II and Ceram.x.mono all the specimens achieved an Alfa score at all the time intervals (Table 4).

Recreant caries

Bleaching and time had no significant effect on the recreant caries parameter. All the specimens achieved an Alfa score at all the time intervals (Table 4).

Marginal adaptation

There were highly significant statistical differences in marginal adaptation among the three composite resins ($p<0.01$). Time also had a highly significant statistical effect on marginal adaptation ($p<0.01$). All the ISP Empress Direct specimens were able to maintain the marginal adaptation for three months after bleaching, while 10% of the specimens showed color mismatch at six months and one year after bleaching; however, this marginal adaptation was clinically acceptable. Regarding Beautifil II and Ceram.x.mono, all the specimens achieved an Alfa score at all the time intervals (Table 4).

Anatomical form

No significant difference was observed in the anatomical form between the three tested composite groups at all the follow-up times ($p>0.05$). However, time had a significant effect ($p=0.049$) one year after bleaching recall. Only 10% in each of the three tested composite groups reported such changes. However, for these three tested composite groups, these changes were clinically acceptable (Table 4).

Surface texture

Bleaching and time had no significant effect on surface texture parameter. All the specimens achieved an Alfa score at all the time intervals (Table 4).

Discussion

Few studies have been performed that deal with the effects of bleaching agents on restorative materials. However, it is difficult to compare the results of these studies due to the variety of restorative materials used. We are unaware of any published studies that are available on the effects of bleaching on some of the restorative materials

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used in this study. In addition, in the literature, only a few publications were found that addressed the effects of in-office bleaching on the surface texture of restorative materials.[17] The differences observed between the present study and these other studies may be due to cavity or lesion types and the types of restoration materials used. Additionally, the shape and size of the restoration lesions, operator variability, occlusal factors, the bonding capacity of the restorative system, application, the curing technique used, and factors during the aging of the restoration, such as temperature and pH cycles in the mouth are factors that could account for the differences between the studies.[18,19] The present study did not show any significant difference among the three materials with respect to retention, secondary caries, and surface texture. At six months and one year after bleaching, marginal discoloration and marginal adaptation were seen in 10% of restorations in the ISP Empress Direct restorations. Marginal discoloration and marginal adaptation may indicate bond breakdown and a leaking margin, thus allowing the ingress of exogenous stains from food and drink, and this not too high percentage refers to the fact that Prime & Bond NT may be due to this bonding capacity of the restorative system not being compatible with this type of restoration.[20] The durability of the restorations depends on the effectiveness of the bond between the restoration and both the enamel and dentin interfaces. Bonding as Prime & Bond NT to tooth structure could be explained by the adhesion mechanism of Prime/Adhesive to dentin and enamel. Adhesive potential is achieved by the ionic bonding of carboxyl and phosphate groups; the acetone component improves this potential by wetting the tooth surface.[21–24] The cavosurface marginal discoloration may be considered as a sign of microleakage, which occurs when there are marginal gaps.[25] Microleakage occurs between the tooth and ISP Empress Direct due to the dissolution action of time and subject behavior, but not due to the effect of bleaching. Materials with lower modulus of elasticity that are used in restorations tend to bend more like a tooth structure when subjected to a masticatory load and may flex and be retained.[22,26] The use of a bonding system results in the creation of an elastic intermediate layer between the filling and the cavosurface.[22–27] It had been claimed that the flexural deformation of the tooth was at least partly absorbed by this elastic layer.[22–28] The present study showed a higher percentage of cases in the ISP Empress Direct group with color mismatch due to an increase in the translucency and the A1 shade only enamel shade, thus making the restoration too bright. Other reasons given for color changes include the retention of extrinsic pigments, surface roughness, incomplete polymerization, residual monomer after light activation, and water sorption.[20–30] Additionally, the esthetic restorations are exposed to the combined effects of light, moisture, stain, and mechanical wear under oral conditions, often resulting in visibly detectable and esthetically undesirable color changes.[18–31] Moreover, it was reported in an in vivo study that potential reasons for the change in color match are caused by the extent of the food materials' effects, water sorption, and early disruption of both the polymerization reactions and surface characteristics.[32] Van Dijken reported that the high content of hydrophilic monomer in hybrid materials causes a high rate of water sorption, resulting in a color change. These factors might explain the color change in the current study.[33] Within the condition of this study, all the materials tested at the one-year recall were considered clinically acceptable.[34] The present study showed that Beautifil II and Ceram.x.mono were significantly better than ISP Empress Direct over a period of one year after bleaching. However, a long-term follow up of the restoration is needed to substantiate the present results.

Conclusion

Within the limitations of this in vivo study, the following conclusion may be drawn: Clinically, color matching between the teeth and restorations for the Beautifil II and Ceram.x.mono composite resin restorations was observed. Mismatching was detected for the IPS Empress Direct composite resin restorations, which was, however, the deterioration in IPS Empress Direct might be due to limitations in the material rather than the bleaching.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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