Received: 2 September 2022 | Revised: 21 October 2022 | Accepted: 16 November 2022

DOI: 10.1111/jerd.12992

WILEY

RESEARCH ARTICLE

Two-year retrospective evaluation of monoshade universal composites in direct veneer and diastema closure restorations

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Abstract

Objectives: The aim of this retrospective evaluation was to assess the short-term outcome of two monoshade universal resin composites with high chameleon effect in anterior direct veneer and diastema closure restorations, and to investigate the possible reasons for failure.

Material and Methods: Patients subjected to veneer and diastema closure restorations with two monoshade universal resin composites (Essentia Universal Shade; EU, GC Corp., and Omnichroma; OC, Tokuyama) operated between January 2018 and March 2019 were selected for the present retrospective evaluation. A total of 159 composite restorations (78 veneers and 81 diastema closure restorations) performed by a single operator in 44 patients (mean age: 33.6) were included in the study. Two blinded and calibrated examiners performed 1- and 2-year assessments of the restorations with respect to FDI criteria, using medical/clinical history and dental photography records. Data were analyzed using Pearson Chi-square with Continuity Correction, Fisher's Exact tests, and Cox regression ($a < 0.05$).

Results: The cumulative overall survival rates of EU and OC restorations were 94.6% (97.3% for the first year) and 88.6% (95.3% for the first year), respectively, with no significant difference from each other ($p = 0.316$). The cumulative overall survival rates of direct veneer and diastema closure restoration types were 90.2% (95.1% for the first year) and 92.4% (97.4% for the first year), respectively, with no significant difference ($p = 0.559$). The reasons for failure were evaluated as fracture of the restoration, failure in esthetic anatomical form, and color mismatch. All the failed direct veneer restorations were due to fractures (FDI score of 5.4), whereas 5 of 6 failed diastema closure restorations were due to color mismatch (FDI score of 3.4). Regarding the composite materials, there were no significant differences between the success rates of the restoration types ($p = 0.442$ for EU, $p = 1.000$ for OC). With respect to the restoration types, there were also no significant differences between the success rates of the resin-based composites ($p = 1.000$ for direct veneer restorations and $p = 0.228$ for the diastema closure restorations). In addition, no significant difference was observed between male and female patients regarding the acceptable and unacceptable scores ($p = 1.000$).

Conclusions: The 2-year clinical performance of the two monoshade universal composites in anterior veneer and diastema closure restorations were both considered

successful and similar. Despite the lack of shade selection, both monoshade universal composites presented a successful color match. However, the diastema closure restorations might be more prone to color mismatch compared to the veneers over time, while veneer restorations presented more fractures than the diastema closure restorations.

Clinical Significance: Monoshade universal composites presented successful short-term clinical outcomes regarding both function and esthetics in anterior direct veneer and diastema closure restorations.

KEYWORDS
diastema, monoshade, single shade, universal composite, veneer, longevity, survival

1 | INTRODUCTION

Perfection in anterior restorations acts as publicity for the skills of a clinician. Most of the restorative procedures in anterior teeth can be accomplished with the direct application of resin-based composites (RBCs).[1] The ability of the dentist in simulating the natural morphology and the properties of the restorative material are the main influencing factors to obtain a satisfying esthetic outcome. The type of RBC and restorative instruments, as well as the clinical restorative protocol significantly affect the quality and longevity of the restorations.[2]

Developments in adhesive dentistry made it possible to perform minimally invasive, direct esthetic restorations in a single visit.[1] The range of directly restorable cases has been expanded along with the developments in adhesive dentistry.[2–4] The development of polymerization units has provided the stratification of RBCs step-by-step with several layers to create various optical effects on the restoration.[2,5] The use of RBC for esthetic purposes started following the announcement of physically and optically improved, special composite kits, offering several opacities and shades.[6] These kits were also integrated with the "Vita Classical" shade guide, to provide ease in shade selection.[5,7] In restorative dentistry, contemporary RBCs are now considered as rivals to the ceramic-based systems.[1,5]

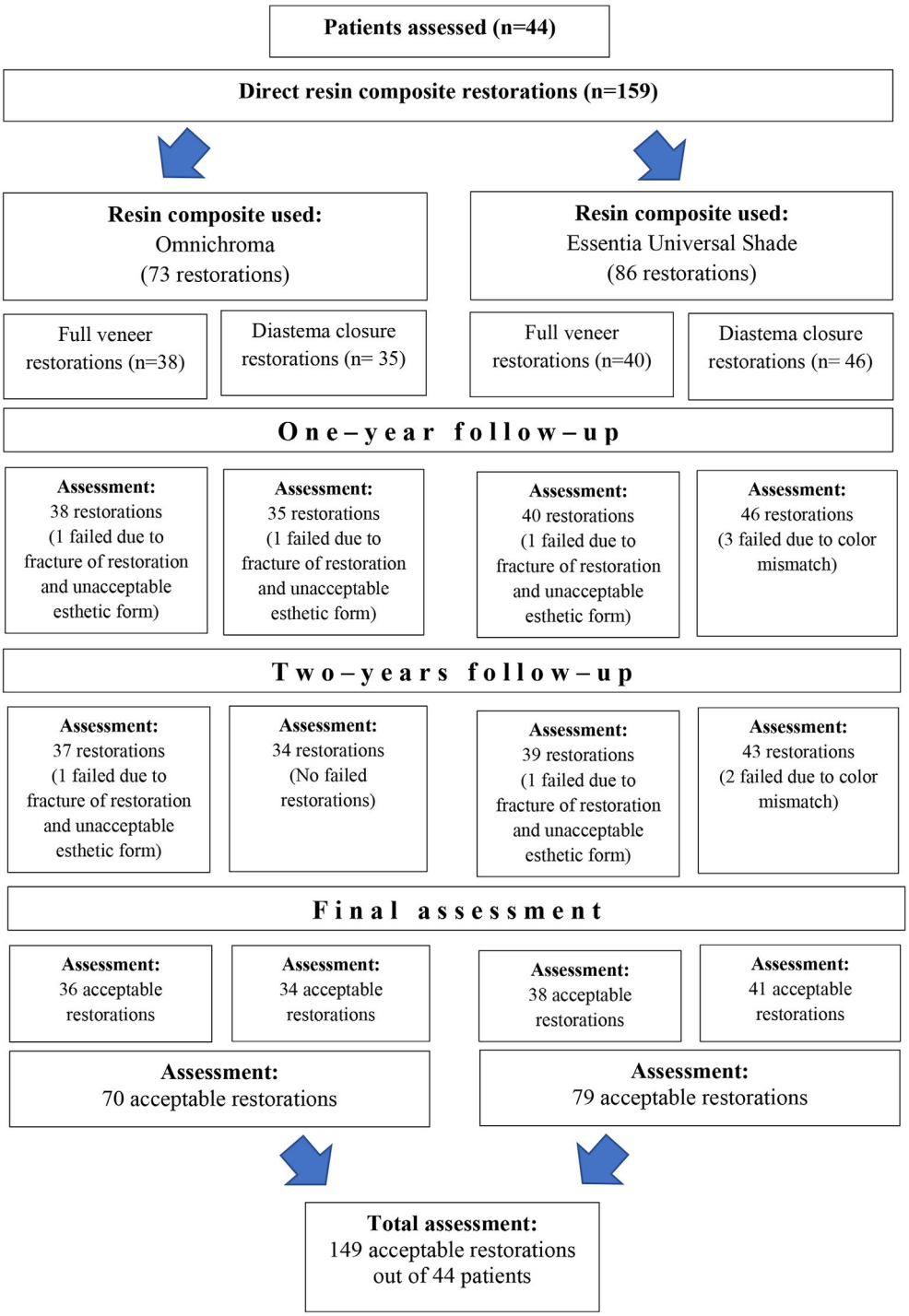
The layering concepts in restorative dentistry using RBCs have evolved to imitate the natural dental morphology, regarding the especially perfect match in many dimensions of tooth color.[6] Dietschi and Fahl,[5] defined the color perceived by the patients, as a correct hue, translucency, opalescence, fluorescence, also surface luster, and light reflection. However, the improvements in esthetic materials and techniques have facilitated the road to esthetic restorations, in terms of simplifying the shade selection.[1,8] Accordingly, it is the level of optical determinants as well as the filler technology and contents that generates the esthetic qualification of the final restoration.[7–10] Proper material and shade selection, and appropriate layering protocol should be determined to obtain an optimal esthetic result.[1,5]

Following the developments in contemporary composite kits, microfilled resins evolved into microhybrid and nanohybrid/nanofilled resins.[2,11] Most recently, spherical-shaped particles were produced to enhance the resin composites' physical, mechanical, and optical properties.[6] Smaller inorganic filler size enables a higher filler loading, providing lower rates of polymerization shrinkage and better polishing properties. As a result, high gloss retention and color stability can be achieved in the long-term.[1,8] Additionally, visible light scatters from the surfaces of nano-sized particles much more than larger particles, resulting in a more chameleon-like (blending) effect.[8] Chameleon effect or color adjustment potential is an esthetic property enabling the restorative material to match the substrate's color, resulting in life-like esthetics.[1,9,12,13] In other words, under the appropriate circumstances, two colors blend by shifting a composite color toward the color of the surrounding.[14] Some nanofilled resin composite materials with color adjustment potential can transfer complex light movements, such as; transmission, diffusion, and reflection, through the tooth structure, thus mimicking the natural tooth color.[9,12] Paravina et al.[12] reported that the chameleon effect was material and shade dependent and increased in smaller restorations compared to large restorations. Bakti et al.[13] reported that the blending effect differed depending on the shade of dentin base, concluding that the decision of monochromatic layering technique should be also tooth dependent.

Currently there are polyshade and/or simplyshade esthetic composite kits in the market that contains 3–40 different shades in different opacities and chromaticities.[1,5] Recently, a few monoshade universal composite materials with just one syringe have been introduced, claiming no need for shade selection.[1,6,7] Large number of shades allow clinicians to create satisfactory as well as life-like composite restorations in a single visit, though the kits containing fewer shades make it easier for the operator. During the stratification, using fewer shades with an increased color adjustment potential might reduce the probability of color mismatch, which was previously considered irreversible clinical complication.[14] Therefore, simplifying the shades in esthetic resin composite kits might be advantageous only if the clinical outcome meets the esthetic demands.[1]

This study aimed to evaluate the 2-year clinical performance of two monoshade universal RBCs used for anterior veneer and diastema closure restorations, according to the Federation Dentaire Internationale (FDI) criteria. The hypotheses (h_0) were that; (1) there will be no significant difference in longevity among the composite or the restoration types; (2) there will be no significant difference in each

FIGURE 1 The study design



evaluated criteria among the composite types, regarding the overall acceptable and unacceptable scores.

2 | MATERIALS AND METHODS

2.1 | Study design and participants

This study was approved by Marmara University Faculty of Dentistry Clinical Research Ethical Committee (approval date/no: 20.01.2022, 2022/34). All the involved patients have signed an informed consent paper informing that the evaluations will be performed through their clinical photographs and the collected anamnesis data. The study population was determined as a minimum of 137 with the G-power program, by taking impact size 0.321 (medium), effect size (Δ) = 0.05, power (1 – β) = 0.80 at a confidence level of 95%, regarding the esthetics, functional and biological FDI criteria.[15]

The design of the study was presented in Figure 1. Patients who received RBC restoration(s) on maxillary and mandibular anterior teeth were selected for this retrospective evaluation. The collected

TABLE 1 Distribution of the restorations according to the restoration date, patient, and restoration type

					Restoration type and distribution	
	Patient number	Age	Gender	Restoration date	Veneer restorations (20 patients, 78 restorations	Diastema closure restorations (24 patients, 81 restorations)
Omnichroma	1	36	Female	2019 Jan	4 restorations	
	2	23	Male	2019 Feb	4 restorations	
	3	51	Female	2019 Feb	6 restorations	
	4	28	Male	2019 Mar	6 restorations	
	5	27	Female	2019 Jan	4 restorations	
	6	43	Female	2019 Feb	4 restorations	
	7	46	Male	2019 Feb	2 restorations	
	8	33	Male	2019 Mar	2 restorations	
	9	24	Female	2019 Jan	4 restorations	
	10	23	Male	2019 Feb	2 restorations	
	11	24	Male	2019 Feb		2 restorations
	12	23	Female	2019 Jan		4 restorations
	13	25	Male	2019 Feb		2 restorations
	14	32	Female	2019 Feb		2 restorations
	15	26	Male	2019 Jan		6 restorations
	16	46	Male	2019 Mar		6 restorations
	17	21	Female	2019 Jan		2 restorations
	18	36	Female	2019 Feb		2 restorations
	19	48	Female	2019 Mar		5 restorations
	20	35	Male	2019 Feb		2 restorations
	21	27	Female	2019 Jan		2 restorations
Essentia Universal	22	41	Male	2018 Nov	2 restorations	
	23	33	Male	2018 June	4 restorations	
	24	22	Female	2018 May	6 restorations	
	25	37	Male	2018 Feb	2 restorations	
	26	25	Female	2019 Jan	4 restorations	
	27	25	Female	2019 Mar	6 restorations	
	28	40	Male	2018 May	3 restorations	
	29	43	Male	2018 Dec	6 restorations	
	30	39	Female	2019 Jan	5 restorations	
	31	32	Female	2018 July	2 restorations	
	32	28	Male	2018 Oct		4 restorations
	33	27	Female	2019 Mar		3 restorations
	34	24	Female	2018 Feb		2 restorations
	35	30	Female	2018 Apr		6 restorations
	36	32	Male	2018 Dec		5 restorations
	37	44	Male	2018 Nov		2 restorations
	38	39	Female	2019 Jan		3 restorations
	39	29	Male	2018 Feb		4 restorations
	40	21	Female	2018 May		6 restorations
	41	28	Male	2018 Oct		4 restorations
	42	33	Male	2019 Feb		2 restorations
	43	34	Female	2018 Mar		2 restorations
	44	29	Female	2018 July		3 restorations

TABLE 2 The distribution of the restorations according to the tooth number

		Tooth number									
Restoration type	***n***	**13**	**12**	**11**	**21**	**22**	**23**	**31**	**41**	**32**	**42**
Veneer	78	7	13	15	14	12	7	4	3	2	1
Diastema closure	81	6	11	17	18	12	5	4	3	3	2
Total	159	13	24	32	32	24	12	8	6	5	3

data of 159 direct composite restorations including veneers ($n = 78$) and diastema closures ($n = 81$) were selected. The restorations were from 21 male and 23 female patients between the ages of 21 and 51 years (mean age, 33.6 years). Restorations were carried out at least 2 years ago, by a single restorative dentistry instructor under rubber-dam isolation. The restorations were performed using two monoshade universal composites (Omnichroma, OC, Tokuyama, Tokyo, Japan, and Essentia Universal Shade, EU, GC Corp., Tokyo, Japan). One-year and 2-year data of the selected restorations were evaluated by two experienced and calibrated restorative dentistry specialists, different from the operator. The distribution of the restorations according to the restoration date, patient, and restoration type was presented in Table 1.

2.2 | Inclusion and exclusion criteria

For this retrospective evaluation, the clinical data, medical history, and photographic data of the patients were collected from the dental records of Marmara University Restorative Department. A total of 159 direct composite restorations (78 veneer and 81 diastema closure restorations), were performed by a single operator in 44 patients (21 female, 23 male/mean age of 33.6), using two monoshade universal composites (OC and EU) were selected from the collected data. The full vestibular surface covering restorations were considered veneer restorations. The selected restorations were performed on anterior teeth (maxillary or mandibular incisors, or maxillary canines) due to caries, diastemas, replacements, and slight malpositions and were operated on between January 2018 and March 2019. The distribution of the restorations according to the tooth number was presented in Table 2. The patients with full anterior dentition and with good oral hygiene (bleeding score of 0 or 1) were included in the study, whereas those who have malocclusion were excluded. Only non-smokers were included in the study. The decision was made by assessment through the collected medical and clinical data and photography records. Restorations of the patients who have bruxism were excluded. The diagnosis of bruxism was based on the collected medical and clinical data and dental photography records. Endodontically treated teeth were excluded. The teeth that were re-polished or repaired during the evaluation time were also excluded from the study.

2.3 | Restorative protocol

The clinical protocol of the restorations was collected from the dental records of the operator. The restorations were performed on maxillary or mandibular incisors, or maxillary canines by an experienced restorative dentistry instructor under local anesthesia and rubber-dam isolation, in a university restorative dentistry department. The same restorative protocols were performed for all the selected restorations. No shade selection was performed, as both RBCs were monoshade universal, smart chromatic materials with high color adjustment potentials. The gingival retraction was performed by using specific anterior rubber-dam clamps (Black Line Clamps, Hu-Friedy, Chicago, USA) to avoid flashlight reflections in macro dental photographs. Before the restorative procedure, remaining restorations were fully removed conservatively if they existed. Preparations were performed only for the veneer restorations minimally invasively, and no preparations were performed for the diastema closure restorations. In the case of preparations, red diamond needle-shaped burs (Dentsply Maillefer, Ballaigues, Switzerland) were used under constant water cooling. About 35% phosphoric acid gel (Ultra-Etch, Ultradent Products, USA) was applied to all of the prepared enamel surfaces for 30 s and rinsed for 30 s then dried with air spray. The adhesive system was selected for the restorations according to the manufacturer of the RBC. For EU restorations, a single bottle, one-step, universal adhesive (G-Premio Bond, GC Corp.); for OC restorations a two-bottle, one-step, self-cured universal adhesive (Universal Bond, Tokuyama) were applied and polymerized (Valo Grand/Standard Power mode, Ultradent Products) on the etched enamel surfaces according to the manufacturer's instructions. A single bottle, one-step, universal adhesive G-Premio Bond and two-bottle, one-step, self-cured universal adhesive Universal Bond were applied to the etched enamel surfaces per the manufacturer's instructions. The adhesive layer was slightly thinned using air spray, and only G-Premio Bond was polymerized for 20 s. Following the G-Premio Bond application, the microhybrid, monoshade universal composite EU, was used for the monochromatic 86 restorations (40 veneer and 46 diastema closure restorations). Following the Universal Bond application, a non-pigmented, supra-nano, monoshade universal composite with spherical inorganic fillers OC, was used for the monochromatic 73 restorations (38 veneer and 35 diastema closure restorations). Omnichroma Blocker (Tokuyama) was not used in any of the selected restorations. In veneer restorations, the entire labial surfaces of the teeth were covered with the respective RBCs, while in diastema closure restorations, RBCs were only added at the proximal area and partially on the labial surface. All restorations were incrementally layered (≤2 mm thickness), using the free-hand additive technique. No specific restorative matrices or templates were used for the restorations; however, specific hand instruments (Restorative and Isolation Kit, Hu-Friedy), composite brush (Compo Brush, Smile Line SA, St. Imier, Switzerland), and wetting resin (Modeling Liquid, GC Corp.) were used. Each layer of OC was

TABLE 3 Comparison of the success in composite materials and restoration types, regarding 1-year and 2-year follow-ups

Follow-up	Score	Omnichroma ($n = 73$)	Essentia Universal Shade ($n = 86$)	Total ($n = 159$)	p
1-year	Acceptable	71 (97.3)	82 (95.3)	153 (96.2)	0.688*
	Unacceptable	2 (2.7)	4 (4.7)	6 (3.8)	
2-years	Acceptable	70 (95.89)	79 (91.86)	149 (93.71)	0.345*
	Unacceptable	3 (4.11)	7 (8.14)	10 (6.29)	
		Diastema closure ($n = 81$)	Veneer ($n = 78$)	Total ($n = 159$)	p
1-year	Acceptable	77 (95.1)	76 (97.4)	153 (96.2)	0.682*
	Unacceptable	4 (4.9)	2 (2.6)	6 (3.8)	
2-years	Acceptable	75 (92.6)	74 (94.9)	149 (93.7)	0.746*
	Unacceptable	6 (7.4)	4 (5.1)	10 (6.3)	

*Fisher's Exact test; *n* (%).

TABLE 4 Comparison of the success in composite materials regarding the restoration types

Restoration type		Omnichroma	Essentia Universal Shade	Total	p*
Diastema closure	Acceptable	34 (97.1)	41 (89.1)	75 (92.6)	0.228*
	Unacceptable	1 (2.9)	5 (10.9)	6 (7.4)	
Veneer	Acceptable	36 (94.7)	38 (95)	74 (94.9)	1.000*
	Unacceptable	2 (5.3)	2 (5)	4 (5.1)	

*Fisher's Exact test; *n* (%).

TABLE 5 Comparison of the success in restoration types regarding the composite materials

		Restoration type			
Composite material	Score	Diastema closure	Veneer	Total	p*
Omnichroma	Acceptable	34 (97.14)	36 (94.74)	70 (95.89)	1.000*
	Unacceptable	1 (2.86)	2 (5.26)	3 (4.11)	
Essentia Universal Shade	Acceptable	41 (89.13)	38 (95)	79 (91.86)	0.442*
	Unacceptable	5 (10.87)	2 (5)	7 (8.14)	

*Fisher's Exact test; *n* (%).

polymerized for 10 s, whereas it was 20 s for EU. A light-emitting diode poly wave curing unit Valo Grand (Ultradent) was used with a light irradiance of 1000 mW/cm^2 and an irradiated diameter of 12 mm for all the restorations. The irradiance was checked weekly using a radiometer (Hilux Led Curing Light Meter, Benlioglu Dental, Ankara, Turkey). The outer surface of the restorations was polymerized under glycerine gel (Air Barrier, GC Corp.) to avoid the formation of the inhibition layer.

Final occlusion was adjusted immediately after the restorations in lateral and protrusive jaw movements of the mandible. As the additive layering technique was used for the restorations, no subtractive finishing was performed for the diastema closure restorations, but rarely performed for the veneers. A 12-bladed tungsten-carbide bur (Diatech SA, Geneva, Switzerland) was used for finishing with a handpiece at 30.000 rpm, under water cooling. Proximal surfaces were polished using interdental strips (Epitex, GC Corp.) in three different grits (medium #500, fine #800, extra-fine #1200). Aluminum oxide (Al_2O_3) embedded abrasive polishing discs (Sof-Lex Discs, 3M, USA) were used to shape cervical and incisal embrasures, and transition lines in three different grain sizes (medium 40 μm, fine 24 μm, and superfine 8 μm), respectively under dry conditions, using a handpiece in 15,000 rpm. Primary morphology (macro surface morphology) was performed using 12–16 blade carbide burs (Acurata, Japan). Secondary/tertiary morphologies were performed using a blue-banded diamond bur (Acurata, Japan), using a handpiece at 8000 rpm, without water cooling. For polishing the labial surfaces, medium-grit and fine-grit diamond particles embedded rubber wheels (Twist Dia, pre-polisher/high-shine polisher, Kuraray Noritake) were used in a counter-clockwise direction, using a low-speed handpiece of 5000–10,000 rpm, with water cooling as per manufacturer's instructions. The restorations were re-polished 1 week after the treatment just for once, regarding the completion of polymerization.

2.4 | Evaluation protocol

Medical and dental history and dental photography records that were collected by the operator at baseline (1 week), 1 year, and 2 years,

TABLE 6 Comparison of the composite materials according to the FDI criteria with score 3

	Omnichroma	Essentia Universal Shade	*p*
Surface luster (score 1.3)	0 (0)	66 (76.7)	**<0.001**[a]
Staining (score 2.3)	1 (1.4)	2 (2.3)	1.000[c]
Color match and translucency (score 3.3)	6 (8.2)	18 (20.9)	**0.045**[b]
Esthetic anatomical form (score 4.3)	10 (13.7)	8 (9.3)	0.535[b]
Fracture of material and retention (score 5.3)	8 (11)	3 (3.5)	0.124[b]
Marginal adaptation (score 6.3)	7 (9.6)	6 (7.0)	0.758[b]
Wear (score 7.3)	73 (100)	86 (100)	-
Proximal anatomical form (score 8.3)	7 (9.6)	6 (7.0)	0.758[b]
Postoperative hypersensitivity, tooth vitality (score 11.3)	73 (100)	86 (100)	-
Recurrence of caries, erosion, abfraction (score 12.3)	73 (100)	86 (100)	-
Tooth integrity/enamel cracks (score 13.3)	73 (100)	86 (100)	-
Adjacent mucosa (score 15.3)	2 (2.7)	4 (4.7)	0.688[c]

[a]Pearson Chi-square.
[b]Continuity correction.
[c]Fisher's Exact test; *n* (%).

TABLE 7 Comparison of acceptable and unacceptable scores between female and male patients

	Female	Male	Total	*p*
Acceptable	81 (93.1)	68 (94.4)	149 (93.7)	1.000*
Unacceptable	6 (6.9)	4 (5.6)	10 (6.3)	

*Fisher's Exact test; *n* (%).

were evaluated, respectively. Photography records were collected with a professional macro dental photography kit, including a full-frame camera (D750, Nikon, Tokyo, Japan), a macro-objective (105 mm macro-VR lens, Nikon), a dual-flash (R1C1, Nikon), and a flash mount bracket (Owlbrckt C, Torun&Torun, Ankara, Turkey) set at 45° angle. The previously collected photography of extra-oral frontal full smile, intra-oral frontal view with and without cross-polarization, maxillary frontal view (using a contrastor; Owlcntrst, Torun&Torun), and frontal close-up view records, taken with standardized camera setup of 1/250 shutter speed, f: 28 diaphragm (F), and 200 ISO, were evaluated. All the photography records were adjusted from the same distance to the patient by using a calibrated dental unit at the university clinic. Calibration of white balance (WB) was performed before the shooting for each patient, using a gray reference card. Following the retraction with transparent lip retractors, the surfaces of the restorations were slightly dried with air spray for intra-oral photography. Each patient's photographs were taken in 2 min individually to avoid dehydration effect on the shade of the teeth and restorations.[8] Maxillary frontal cross-polarization photographs using specific cross-polarization filters (PolarEyes, PhotoMed, CA, USA) were also taken to obtain more descriptive data, regarding the color match and discoloration of the restorations. Photos were saved in JPEG format in high resolution. The collected data was archived according to the patient's name, teeth number, and date, in an SSD hard drive, and in the cloud.

Two experienced and fully blinded observers retrospectively evaluated 159 composite restorations through the medical/clinical history and dental photography records. Before the evaluation, the observers evaluated a set of reference photographs, other than the study data, illustrating the criteria of FDI scores for calibration. The reference photographs were evaluated by both examiners separately twice, at 2-day intervals between each examination. The sensitivity between the observers was determined as 100%, regarding acceptable and unacceptable scores. Cohen's kappa statistics were also used to evaluate the intra- and inter-observer agreement.[16] Good inter-observer's agreement (ICC kappa value of 83) and intra-observer's agreement (ICC kappa values of 92 and 94) were obtained; thereby the evaluation phase of the study was initiated. The two observers assessed and scored the restorations according to the FDI clinical criteria.[17] The selected FDI criteria for this study were: esthetic properties (1–4), functional properties (5–8), and biological properties (11–13, 15). The need for renewal, repair, or repolishing was considered a failure.

2.5 | Statistical analysis

The statistical analyses were performed using IBM SPSS V23 (SPSS, Chicago, IL). Pearson Chi-square with Continuity Correction and Fisher's Exact Test were performed for the assessment of the composite materials according to the FDI criteria. Fisher's Exact Test was performed for the analysis of the success rate among male and female patients. The success rate of the composite materials and restoration types was analyzed using Fisher's Exact test. The survival rates of the two monoshade universal RBCs and the restoration types were assessed using Cox regression. The significance level was set at $p < 0.05$.

3 | RESULTS

At the end of 1 year, 153 restorations, and at the end of 2 years 149 restorations were evaluated as acceptable. The proportion survival rate (SR) of overall restorations for 1-year assessment was 97.3%, and the cumulative proportion overall survival rate (OSR) for 2-year assessment was 91.4%, considering the composite repair and repolishing as failures. OC presented a 97.3% survival rate for 1 year and a 94.6% cumulative survival rate for 2-year assessments, whereas EU material presented a 95.3% survival rate for 1 year and 88.6% cumulative survival rate for 2 years. No significant difference was observed between the two monoshade universal composites when 1- and 2-year data were compared ($p = 0.316$).

At the end of the 2 years, 5 restorations got FDI scores of 4.4 and 5.4 at the same time, therefore OC presented 6 and EU presented 9 unacceptable scores. The reasons for failure were considered fracture of restoration ($n = 5$), failure in esthetic anatomical form ($n = 5$) and color mismatch ($n = 5$) (Figure 1). All unacceptable scores were "score 4," and "score 5" was not evaluated in this study for any of the restorations through the 2-year period. OC presented a 4.1% failure rate with 3 failed restorations, whereas it was 8.1% for the EU with 7 failed restorations. However, no significant difference was observed between the restorations performed with the two RBCs regarding the failure rates ($p = 0.147$). Regarding both 1- ($p = 0.688$) and 2-year ($p = 0.345$) assessments, there was no significant difference between OC and EU in terms of the overall acceptable and unacceptable scores (Table 3). Moreover, there was no significant difference between the success rates of the monoshade universal composites, regarding the restoration types ($p = 0.228$ for the diastema closure restorations and $p = 1.000$ for the veneers) (Table 4).

Regarding the restoration type, the diastema closure restorations presented a 95.1% survival rate for 1 year and 90.2% cumulative survival rate for 2-year assessments, whereas the veneer restorations presented a 97.4% survival rate for 1 year and 92.4% cumulative survival rate for 2 years. No significant difference was observed between the two restoration types in terms of the comparing 1 and 2 years ($p = 0.559$). The respective failure rates for veneer and diastema closure restorations were 2.6% and 2.9% regarding the failed restorations, whereas 5.12% and 7.40% regarding the FDI failure scores. No significant difference was observed between the restoration types in terms of the failed restorations ($p = 0.546$). No significant difference was observed between veneer and diastema closure restorations in both 1- ($p = 0.682$) and 2-year ($p = 0.746$) assessments in terms of the overall acceptable and unacceptable scores (Table 3). The considered failed scores for the

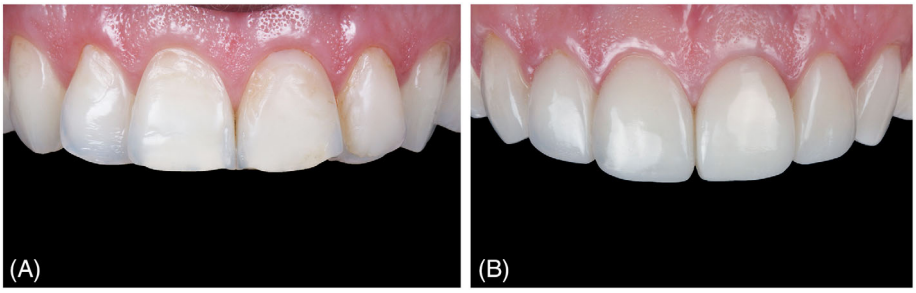


FIGURE 2 (A and B) Veneer restorations on maxillary incisors and canines, with good clinical outcomes

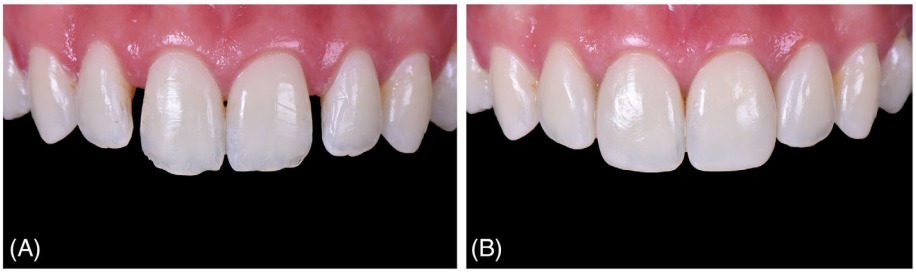


FIGURE 3 (A and B) Diastema closure restorations on maxillary incisors, with good clinical outcomes

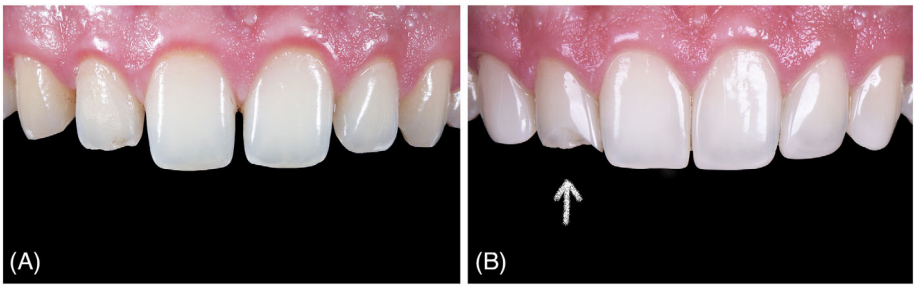


FIGURE 4 (A and B) Veneer restoration on maxillary right lateral incisor with EU, that failed due to fracture of restoration and related unacceptable esthetic anatomical form

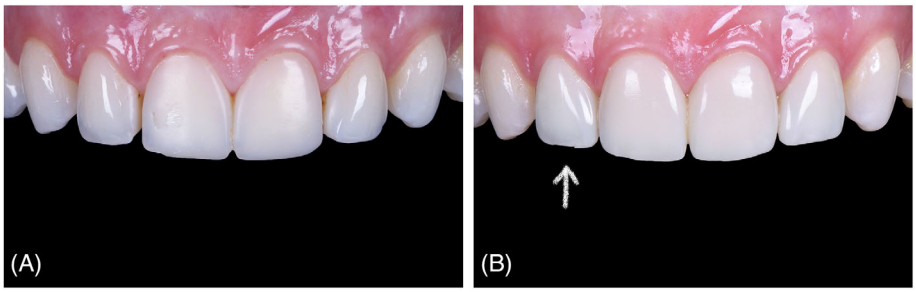


FIGURE 5 (A and B) Veneer restoration on maxillary right lateral incisor with OC, that failed due to fracture of restoration and related unacceptable esthetic anatomical form

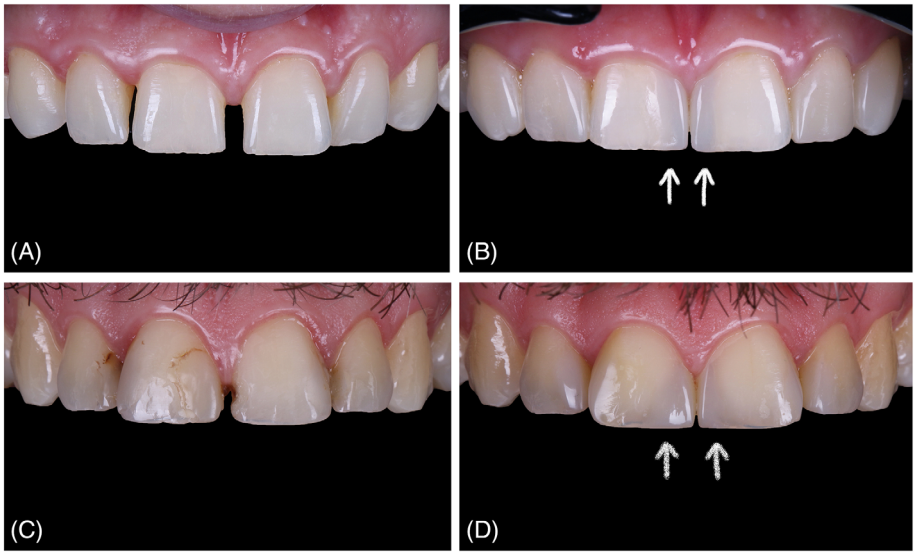


FIGURE 6 (A–D) Major diastema closure restorations on maxillary central incisors with EU, that failed due to color mismatch and translucency

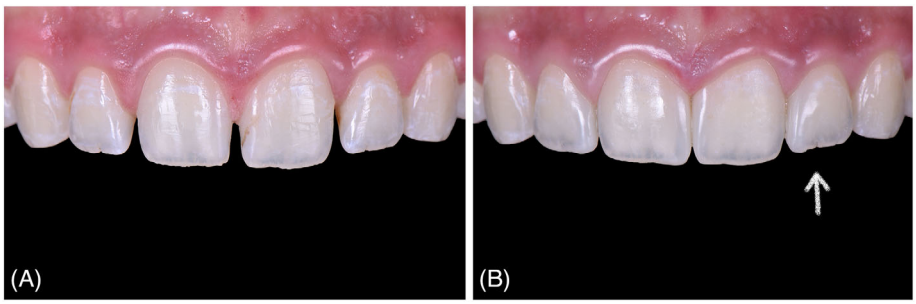


FIGURE 7 (A and B) Diastema closure restoration on maxillary left lateral incisor with OC, that failed due to fracture of restoration and related unacceptable esthetic anatomical form

veneer restorations were all because of the fracture of restoration (FDI score of 5.4), however in the diastema closure restorations, 5 out of 6 failed scores were considered the color mismatch (FDI score of 3.4). Similar success rates were observed for the two restoration types, performed with OC ($p = 1.000$) and EU ($p = 0.442$) (Table 5).

A comparison of the composite materials according to the FDI criteria within the acceptable score 3, was also listed in Table 6. OC presented significantly better scores for the surface luster ($p < 0.001$) and the color match and translucency ($p = 0.045$) criteria. For the rest of the criteria, there were no significant differences regarding score 3 ($p \geq 0.05$) (Table 6).

There were no significant differences regarding the acceptable and unacceptable scores between female and male patients in terms of the 2-year scores ($p = 1.000$) (Table 7).

3.1 | Clinical images

Figures 2–7 are examples of the evaluated macro photographs of the restorations at 2-year follow-up appointments. The accepted veneer and diastema closure restorations with good clinical outcomes were presented in Figures 2 and 3, respectively. The failed veneer and diastema closure restorations operated with OC and EU were shown in Figures 4–7.

4 | DISCUSSION

In this retrospective study, the 2-year clinical evaluation of two monoshade universal composite materials with enhanced color adjustment

potential was performed. The first research hypothesis was accepted with regards to the similar longevity results for the composite types ($p = 0.316$) and the two restoration types ($p = 0.559$) in both 1- and 2-year outcomes. The second hypothesis was also accepted as no difference was found between the composite types for the overall acceptable and unacceptable scores in each evaluated criteria, regarding 1- ($p = 0.688$) and 2-year ($p = 0.345$) assessments (Table 3).

The FDI criteria were used to assess the restorations in this study. Previously, it was reported to be a more descriptive method allowing precise, standardized, and detailed evaluation of restorations for the observers, compared to the United States Public Health Service (USPHS) criteria.[1,17] A greater number of evaluation scores (1–5) in FDI criteria allows observer to assess even minor differences, hence increasing the quality of clinical judgment on restorations.[15,18–20]

A retrospective designed study may result in some deficiencies, such as the incomplete standardization of indications, treatment protocols, or the missing baseline scoring.[21] Dietschi et al.[22] stated that composite technology or curing mode has limited or no effect on durability of restorations, but the treatment environment and the number of operators have the potential to impact the failure or longevity rates. In the present study, all restorations were performed by an experienced university instructor, therefore the potential risk factors regarding the study design might have been relatively inhibited.

Monoshade universal composites are claimed to have an advanced blending effect according to the natural color of surrounding dental tissues, however, to blend correctly, the resin needs underlying dental tissue (enamel and/or dentin) substantially.[23] Regarding large class IV cavities, the lack of enough underlying dental tissue may influence the blending effect adversely. Whereas the amount of essential surrounding dental tissue was not specified clearly by the manufacturers generally. Instead, additional opaque resin composite materials are suggested to be used as a base for these cavities.[23] Therefore, to avoid the potential problems about shade matching mechanisms of these composites, veneer and diastema closure restorations were evaluated rather than class IV restorations in this study.

The cumulative OSR for a 2-year assessment of the restorations was considered 91.4%, which was slightly greater than the results of Coelho-de-Souza et al.[15] (3.5-year survival rate of 80.1%), Frese et al.[24] (5-year survival rate of 84.6%), Peumans et al.[25] (5-year survival rate of 89%), Gresnigt et al.[26] (3.5-year survival rate of 87.5%), Korkut and Turkmen[1] (4-year survival rate of 90.3%). The longevity of the restorations decreases by aging thus, this difference might be because of the shorter evaluation period, which was one of the limitations of this study. Two years might be a short period to evaluate the longevity of anterior restorations clinically, however, this research is one of the few clinical studies for the evaluation of contemporary monoshade universal resin composites in literature.[27] Nevertheless, Demarco et al.[28] determined in a systematic review that the reported survival rates ranged from 53.4% to 100%. Accordingly, Poyser et al.[29] reported a survival rate of 94% for a 2.5-years follow-up period. In addition, performing all the restorations by a single experienced operator, under similar conditions and clinical protocols might have positively influenced our survival rate.[22]

In the present study, although the survival rates were similar for the two monoshade resin composites ($p = 0.316$), the slightly higher survival rates for OC might be due to the uniform-sized 260 nm supra-nano spherical inorganic fillers, compared to the microhybrid EU composite, which was indicated for posterior restorations.[1] Consistent with that, a slightly higher rate of survival was previously reported for Estelite Asteria, which has supra-nano spherical fillers compared to the microhybrid EU and nanohybrid Ceram.x One Spheretec composites.[1] Another retrospective study reported no significant difference between monochromatic crown fracture restorations performed with the EU and polychromatic restorations performed with micro-nanohybrid Essentia MD and LE shades, in terms of 4-years of clinical evaluation.[23] In addition, Massano et al.[30] reported a good clinical performance for a nanofilled resin in anterior restorations over 2.7 years. Lempel et al.[21] considered a 3.7 times greater risk for failure for microhybrid composites than nanofilled composites in terms of direct restorations.

The respective failure rates 2.6% and 2.9% for veneer and diastema closure restoration types are within the reported range of failure rates of the systematic review of Demarco et al.[28] (ranging from 0% to 4.1%) and compatible with the rates of Gresnight et al.[26] (3.2%) and Massano et al.[30] (2.4%). All the failed restorations had score 4, and had more than one clinically unacceptable score, thus the number of unacceptable scores was greater than the number of failed restorations (Figure 1). Failure scores of "esthetic anatomical form" were always accompaniments of "fracture of restoration" scores, consistent with the previous clinical results.[1,23] The main reason for failure was considered as "fracture of restoration" according to Frese et al.,[24] van Dijken et al.,[31] Coelho-de-Souza et al.,[15] Milosevic and Burnside,[32] Gresnigt et al.,[26] Lempel et al.,[21] Korkut and Turkmen,[1] and Korkut and Özcan.[23] Consistent with these reports, "fracture of restoration" ($n = 5$) was one of the equivalent reasons for failure in our study (Figures 4B, 5B, and 7B). The reason for the fractures might be unidentified parafunctional habits such as clenching or acute trauma as mentioned previously.[1,23] With regards to the previous statements of Demarco et al.[28] and Heintze et al.[2] claiming that the restorations involving the incisal edge are under a higher risk of restoration fracture; according to our results, the fracture of restoration was considered the main reason for failure for the veneer restorations (Figures 4B and 5B), whereas it was a color mismatch for the diastema closure restorations (Figure 6B,D). Five of six failed scores in diastema closure restorations were due to color mismatch. This observation might be remarkable, as the main claim of the universal composite materials is the high level of color matching ability.[1] Nevertheless, although the reasons for failures were different, the diastema closure and veneer restoration types presented similar success rates in our study, when evaluated for the overall scores ($p = 0.746$) and also for the individual resin composite scores ($p = 1.000$ for OC; $p = 0.442$ for EU) (Tables 4 and 5). The similar success rates might be opposed to the previously reported results considering greater failure rates for direct veneers/larger restorations among other anterior restorations.[1,2,15,28,33] The color matching failures for the diastema closure restorations are probably the reason for these controversial results.

The relatively short-term evaluation period of this study might have also affected the outcome.

The color of RBCs changes after polymerization, therefore the decision of color matching/mismatching should be considered at least 24 h after polymerization.[34,35] Accordingly, although the evaluation period in this study was relatively short, it was quite appropriate for the evaluation of color match and translucency criteria. All the restorations were performed using composites with high color adjustment potentials, without performing the shade selection with regards to the claim of the manufacturers that they have the ability to match all 16 Vita Classic shades A1 to D4.[1,7,23] According to our results, all 5 unacceptable color mismatch scores (FDI score of 3.4) were observed for the restorations performed with EU (94.2% acceptable color matching), whereas the restorations performed with OC presented 100% acceptable color matching through the 2-year period (Figure 1). This result was compatible with in vitro result of Pareira Sanches et al.[16] in which OC matched the random natural color of 73 posterior dentures with a success rate of 100%, for both instrumental and visual inspections. In addition, consistent with Paravina et al.[12] and Bakti et al.[13] reporting supra-nano spherical filler containing RBCs showing the greatest blending effect. According to the manufacturer, the respective refractive index of the OC monomer is 1.47 and 1.52 before and after polymerization, meaning that the opacity of the material decreases after light curing.[16] This might be the reason for the high color matching ability of this material. Consistent with that statement, Paravina et al.[12] reported a strong correlation between the translucency parameter and the chameleon effect, and Kobayashi et al.[35] considered a lower level of opacity and light diffusion in OC composite resulting in a more esthetic appearance in anterior restorations. Although the scores of 3 were considered clinically successful, the restorations performed with OC also presented relatively fewer scores of 3 for the color match and translucency criteria (FDI score of 3.3) and additionally for the surface luster criteria (FDI score of 1.3) (Table 6). Supporting this result, the highest color, lightness, hue, and translucency adjustments were recorded for the OC, in a previous in vitro study by Durand et al.[36] The observed greater staining in restorations with EU might be the result of the dull and rough surfaces. Organic matrix wears first for the resins with greater filler sizes, followed by the inorganic fillers. Meanwhile, voids may form on the surface. The greater amount and hardness of the inorganic fillers may inhibit the surface wear, whereas fillers in spherical shape may also prevent the formation of the voids.[1,37] Accordingly, in our study, the harder and 260 nm spherical silica-zirconia fillers in OC might have inhibited the surface voids providing a better polishability and a better surface luster.[38] Despite the similar inorganic filler ratio in OC (79 wt%) and EU (81 wt%) composites, the rough restoration surfaces in EU might be due to the greater size of microfillers included (1.7 μm pre-polymerized strontium glass fillers in 400 nm, 1.6 μm pre-polymerized silica fillers in 16 nm, and fluoroaluminosilicate glass fillers in 850 nm),[1,16] which probably plays an effective role in inhibiting the level of polishability of the material.

In the present study, repaired or repolished restorations were considered failures and were scored accordingly. However, it is important to emphasize that the failed restorations' durability might have been extended with a simple composite repair protocol, owing to the resin composite's main advantage. The repairability of resin composites was previously mentioned as the most important factor in extending the longevity of restorations, thus suggesting the repaired cases to be defined, not as failures.[1,24] In addition, Demarco et al.[39] have pointed out that the current classification should be rediscussed, because of the remaining of the repaired restorations in function. It has been concluded that repaired restorations could not be considered complete failures. Frese et al. mentioned a 5-year functional survival rate (including repair) of 100%, besides a survival rate of 84.6%.[24] Korkut and Turkmen stated a 4-year functional survival rate (including repair) of 100%, besides a survival rate of 90.3%.[1] Consistent with these reports, in our study, the 2-year functional survival rate was considered 100%, if the failed restorations were determined as repaired and remained functional.

Peumans et al.[25] reported dental photography scores on the color match and translucency to be slightly better than direct clinical scores, with no significant difference between ($p \geq 0.05$) and Korkut and Turkmen[1] supported that statement. However, they warned not to perform a one-sided view for photographic evaluation, to avoid masking imperfections. In addition, Jokstad et al.[27] indicated that the indirect photographic evaluation technique was more sensitive compared to direct clinical evaluation, due to obtaining reflectance spectra records, unlikely direct evaluation. De Abreu et al.[14] determined DSLR cameras with cross-polarizing filters as reliable instruments providing high-quality images suitable for shade analysis. With regards to the reports of these authors, in this study, the evaluation of FDI criteria was undergone through clinical photography records. All photographs were taken using the same setup for standardization and cross-polarization photography was used to obtain more descriptive data, regarding the color match and discoloration of the restorations. The use of these filters was previously determined as the most accurate technique for dental photography as it showed the lowest color change compared to the use or not of a gray reference card.[40]

This retrospective study has some limitations. The clinical evaluation period was 2-year, which was relatively short compared to the previous longevity studies.[1,21,24,26] However, there is a lack of available clinical data regarding the contemporary monoshade universal resin composites in literature and this short-term evaluation might be useful to assess the clinical success of these materials. Further mid-term and long-term evaluations should be performed to get more reliable results. The eating habits of the patients, which may also have an effect on the final esthetic outcome of the restorations were not assessed in this study.

5 | CONCLUSION

The 2-year clinical performance of the two monoshade universal composites in anterior veneer and diastema closure restorations were both considered successful and similar. Despite the lack of shade selection, both monoshade universal composites presented a successful color match, though the diastema closure restorations might be more prone to color mismatch compared to the veneers over time,

while veneer restorations presented more fractures than the diastema closure restorations.

DISCLOSURE

The authors declare that they do not have any financial interest in the companies whose materials are included in this article.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in Eistatistik at https://eistatistik.com.

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How to cite this article: Korkut B, Ünal T, Can E. Two-year retrospective evaluation of monoshade universal composites in direct veneer and diastema closure restorations. *J Esthet Restor Dent*. 2022;1-13. doi:10.1111/jerd.12992