Original Article

Comparison of Two Different Composite Resins Used for Tooth Reshaping and Diastema Closure in a 4-year Follow-up

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ABSTRACT

Aims: This aim of this study is to evaluate and to compare the clinical performances of two nanohybrid composite resin systems used for diastema closure and tooth reshaping at 4 years. **Subjects and Methods:** Twenty-three patients with midline or multidiastema problem were enrolled in this study. Nanohybrid resin composite systems to be used on each patient were randomly selected. Thirty seven teeth of 10 patients were restored with Filtek-Z550 (3M/ESPE) in combination with Adper™ Single Bond 2 (3M/ESPE) etch and rinse adhesive in Group 1 whereas 39 teeth of 13 patients were restored with Charisma-Diamond (Heraeus Kulzer) in combination with Gluma2 Bond (Heraeus Kulzer) etch and rinse adhesive in Group 2, by two operators. Esthetic, functional, and biological properties of the restorations were evaluated at baseline, 1, 2, 3, and 4 years using foreign direct investment criteria by two independent examiners. **Statistical Analysis Used:** The data were evaluated using Fisher's Chi-Square ($P = 0.05$). **Results:** Fifty-eight restorations (19 patients) with a mean service time of 43.4 months were evaluated (recall rate 82.6%). One Filtek-Z550 and two Charisma-Diamond restorations were repaired due to partial fracture (Score 4). Survival rates of Group 1 and Group 2 were 96.3% and 93.5%, respectively (Kaplan–Meier) ($P > 0.05$). Qualitative deteriorations were observed within each group according to baseline regarding surface luster, surface/marginal staining, marginal adaptation, patient's view, and periodontal response ($P < 0.05$). However, there were no significant differences between two restorative materials for any of the criteria assessed ($P > 0.05$). **Conclusions:** Both nanohybrid composite resin systems revealed esthetically, functionally, and biologically acceptable clinical performance when used for diastema closure and tooth reshaping at 4 years.

Keywords: *Clinical performance, composite resin buildup, diastema closure*

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Introduction

Irregular tooth position, shape, and diastemas in the anterior region are major esthetic problems for patients. Today, a variety of treatment methods are available to manage such situations, including orthodontic treatment, crowns, laminate veneers, and direct composite resin restorations.[1] Indirect restorative options generally require preparation, which is potential destruction of healthy tooth structure. However, direct techniques, are more consistent with the concept of minimally invasive dentistry. In recent years, esthetic improvement of healthy tooth has increasingly been done noninvasively by reshaping tooth with direct composite resin buildups.[2] Adhesive resin technology enables clinicians to add composite resins to tooth surfaces to close gaps and reshape tooth form without any tooth preparation. This option creates new possibilities for minimally invasive dentistry since the tooth shape; position, and color can be altered without loss of tooth tissues.[1,2] Although clinical experience with this

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treatment option is promising, evidence-based data are limited.[1-3]

During the last decades, the use of composite resins for esthetic restorative procedures has increased owing to improvements in adhesive systems and composite resin materials. Due to the advancements in filler technology, the fillers in composite resins changed from macroparticles to nanoparticles through which esthetic and mechanical properties of the materials are improved.[4] Besides the traditional filler particles, most nanohybrid resin composites contain small concentrations of nanofillers and/or nanofiller clusters that increase the filler load, improve mechanical properties, and produce highly polishable surfaces.[5] Nanocomposites exhibit high translucency and smoothness retention similar to those of microfilled composites while maintaining the physical properties and a wear resistance equivalent to those of several hybrid and microhybrid composites. Therefore, by virtue of their strength and esthetic properties, nanocomposites are recommended to be used in both anterior and posterior restorations.[3,5-7] In spite of numerous studies about the clinical performance of posterior composite restorations,[7-9] evaluation of anterior direct composite resin restorations and direct composite buildups within past decades have been rare[1-3] as are data on their performance.

The objective of this clinical study, therefore, was to evaluate and to compare the clinical performances of two nanohybrid resin composite systems used for anterior diastema closure and tooth reshaping during 4 years. The hypothesis tested was that both nanohybrid resin composites with their bonding agents would function similarly in clinical conditions.

Subjects and Methods

The study protocol was approved by the Ethical Committee of Hacettepe University, Ankara, Turkey and the Ethical Committee of Ministry of Health (protocol HEK 2014/03-14 (KA-14004)). Between December 2011 and August 2012, a total of 23 patients (6 males, 17 females, mean age: 31.27) with maxillar anterior midline or multidiastema problem received 76 direct composite resin restorations. Before entering the trial, all patients were asked to sign an informed consent form and information was given to each patient regarding the alternative treatment options. The inclusion criteria were as follows: All participants were required to be at least 18 years old, able to read and sign the informed consent document, physically and psychologically able to tolerate the restorative procedures, having no active periodontal or pulpal diseases and willing to return for follow-up examinations as outlined by the investigators.[4] The exclusion criteria were uncontrolled parafunction, insufficient oral hygiene leading to caries lesions more than twice yearly during the previous 2 years, being pregnant or nursing and having periodontal disease.[3]

The teeth to be restored were first cleaned with pumice-water slurry using a rubber cup. The appropriate shade of restorative material was selected using a standard VITAPAN® Classic shade guide, and initial intraoral photographs were taken. Teeth were then isolated using cotton rolls, and Mylar strips were placed with the help of wedges interproximally to achieve a smooth and overhang free restoration outline in the cervical area and to form final restorations. The surfaces to be restored were etched using 35% orthophosphoric acid for 30 s according to the restorative system used. The etched surfaces were rinsed and dried. The nanohybrid composite resin systems to be used on each patient were randomly selected. Thirty-seven teeth of 10 patients were restored with Filtek-Z550 (3M/ESPE, St. Paul, MN, USA) in combination with Adper™ Single Bond 2 (3M/ESPE, St. Paul, MN, USA) etch and rinse adhesive; whereas 39 teeth of 13 patients were restored with Charisma-Diamond (Heraeus Kulzer, GmbH, Germany) in combination with Gluma2 Bond (Heraeus Kulzer, GmbH, Germany) etch and rinse adhesive by two operators. Every material used in this study was used according to the manufacturers' instructions [Table 1]. The composite increments were carefully placed between the matrix strip and tooth using a hand instrument. The matrix was then gently closed facially beginning from the gingival aspect.[3,10] When restorations for tooth shape corrections covered a large portion of the labial surfaces, the mesial and distal buildups were joined labially. Therefore, the composite buildups for shape correction were performed as single restoration including labial and proximal surfaces. Then, the restorations were light cured using a photo-curing light (Radii Plus, SDI, Bayswater, Australia), by placing the tip of the device 2 mm away from the composite resins. The curing light intensity was measured before and after application to ensure that the light output was never below 600 mW/cm^2. Restorations were gradually buildup by layering the composite resins with maximally 2 mm thick increments to obtain the final shape or contour as described above.[3,10] Occlusion was checked with thin articulating papers. Lingual restoration surfaces were finished and polished with fine finishing diamond burs, stones, and rubber cups whereas proximal and labial surfaces were contoured and polished with Finishing Strips (3M/ESPE, St. Paul, MN, USA). The treatments were completed by instructing the patients about the oral hygiene measures for cleaning their restorations with toothbrush and dental floss. Furthermore, the patients were instructed regarding

the evaluation periods and were requested to cooperate. Patients were also instructed to call on any kind of failure. Then, intraoral photographs were taken to assist further evaluation at baseline and each control period for evaluating the short- and medium-term changes in the restorations.

Two calibrated observers who were blinded to the objective of this study performed the evaluations. For maximum validity, the observers were calibrated using the web-based training and calibration tool www.e-calib.info[11] recommended by foreign direct investment (FDI). Both observers evaluated the esthetic, functional, and biological properties of the restorations independently at baseline, 1, 2, 3 and 4 years using FDI Criteria establishing a score-range of 1–5 (1-clinically excellent/very good, 2-clinically good, 3-clinically sufficient/satisfactory, 4-clinically unsatisfactory, and 5-clinically poor).[11] After data collection, in case of discrepancies in scoring, restorations were evaluated again, a consensus was reached, and this was accepted as the final score.

Statistical analysis was performed with SPSS version 15.0 software (IBM Corp., Chicago, IL, USA). To compare the performance of restorative materials according to FDI criteria over the study period, the Fisher's Chi-Square test was used. The Cochran Q-test was then used to compare the 1, 2, 3, and 4-year scores of each material with baseline scores to evaluate the changes of each dependent group by the time. Survival curves were obtained using Kaplan–Meier method. $P < 0.05$ was considered to be statistically significant in all tests.

Results

The mean observation time was 43.4 months with a minimum observation period of 37 months and maximum 48 months. During the evaluation period, 4 patients with 18 restorations (eight Charisma-Diamond restorations bonded with Gluma 2Bond and 10 Filtek Z550 restorations bonded with Adper Single Bond 2) dropped out from the study, and at final recall, 19 patients with 58 restorations were evaluated (recall rate 82.6%).

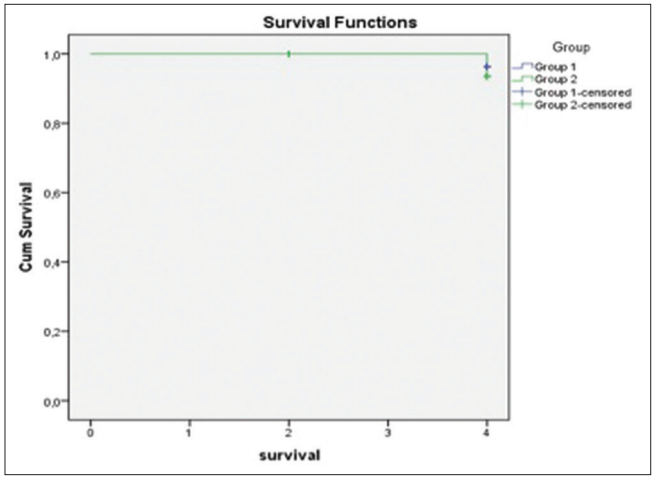

Figure 1: Kaplan–Meier survival curves for each group

Two Charisma diamond restorations were repaired due to partial fracture at 3 years, and 1 Filtek-Z550 restoration was repaired at 4 years with the same reason. Overall, survival rates of the Filtek-Z550 and Charisma-Diamond restorations were 96.3% and 93.5%, respectively [Figure 1]. The survival rates of the groups did not show significant differences ($P = 0.64$).

In Table 2, the evaluation findings of the esthetic properties for the restorations are shown. At 4 years, the surface luster of 7 Filtek-Z550 restorations and nine Charisma-Diamond restorations were scored as 2. Six Filtek-Z550 restorations and five Charisma-Diamond restorations exhibited minor surface staining (Score 2). Minor marginal staining (Score 2) was observed on 10 Filtek-Z550 restorations and nine Charisma-Diamond restorations whereas two Filtek-Z550 restorations showed moderate marginal staining (Score 3). Two Filtek-Z550 and six Charisma-Diamond restorations revealed minor deviations in shade and translucency (Score 2). The form of two Charisma-Diamond restorations slightly deviated from normal (Score 2) whereas unacceptable deviations that need intervention (Score 4) were observed for one Filtek-Z550 at 4th year and for two Charisma-Diamond restorations at 3rd year. The rest of the restorations in both groups were clinically excellent (Score 1) and there were no significant differences between two groups at any recall for the esthetic properties assessed ($P < 0.05$).

The findings of the functional properties of the restorations are summarized in Table 3. Less than half of the one Filtek-Z550 and two Charisma-Diamond restorations were fractured and lost (Score 4) during 4 years. Those restorations were also clinically unsatisfactory but repairable (Score 4) for marginal adaptation, proximal anatomical form, and patient's view. Six Filtek-Z550 and seven Charisma-Diamond restorations exhibited minor irregularities in marginal adaptation (Score 2). Major irregularities were observed in Filtek-Z550 restoration, which were clinically acceptable (Score 3). Somewhat weak proximal anatomical contacts within clinically acceptable limits were observed on 7 Charisma-Diamond restorations (Score 3). Four Charisma-Diamond restorations showed slightly deficient contour (Score 2). Patients' views were clinically good for four Filtek-Z550 and two Charisma-Diamond restorations (Score 2). Besides, the differences on the functional properties of the restorations were not significantly different at any time ($P > 0.05$). Representative photographs from each group are shown in Figures 2 and 3.

Figure 2: (a) Preoperative intraoral view. (b) Intraoral view of composite buildups on teeth number 12, 11, 21, 22 with Filtek-Z550 at baseline. (c) Intraoral view of composite buildups on teeth number 12, 11, 21, 22 with Filtek-Z550 at 4 years

Figure 3: (a) Preoperative intramural view. (b) Intraoral view of composite buildups on teeth number 12, 11, 21, and 22 with Charisma-Diamond at baseline. (c) Intraoral view of composite buildups on teeth number 12, 11, 21, 22 with Charisma-Diamond at 4 years

Table 1: Materials used in the study

Material	Composition	Manufacturer and batch number	Application
Filtek-Z550 (Shade A2-A3)	Matrix: Bis-GMA, UDMA, Bis-EMA, TEGDMA, PEGDMA Fillers: Surface-modified zirconia/silica fillers, nonagglomerated/nonaggregated surface-modified silica particles (82 wt%, 68 vol% filler load)	3M ESPE, St. Paul, MN, USA N276151	Apply as maximum 2 mm increments Light cure for 20 s
Adper™ Single Bond 2	Bis-GMA, HEMA, dimethacrylates, ethanol, water	3M ESPE, St. Paul, MN, USA 587885	Apply 2-3 consecutive coats of adhesive to etched enamel 15 s with gentle agitation using a fully saturated applicator Gently air thin for 5 s to evaporate solvents Light cure for 10 s
Charisma-Diamond (Shade A2-A3)	Matrix: TCD-DI-HEA, UDMA Filler: Barium aluminum fluoride glass (81 wt%, 64 vol% filler load)	HERAEUS KULZER, GmbH, Germany 6	Apply as maximum 2 mm increments Light cure for 20 s
Gluma 2Bond	Methacrylate, ethanol, fillers, photoinitiators, and glutaraldehyde	HERAEUS KULZER, GmbH, Germany 010029	Apply to the etched enamel and set for 15 s Air blow gently to evaporate the solvent Light cure for 20 s

Bis-GMA=Bisphenol-A-glycidyl dimethacrylate; UDMA=Urethane dimethacrylate; Bis-EMA=Bisphenol A diglycidyl methacrylate ethoxylated; TEGDMA=Triethylene glycol dimethacylate; HEMA=2-hydroxyethyl methacrylate; PEGDMA=Poly(ethylene glycol) dimethacrylate; TCD-DI-HEA=2-Propenoic acid, octahydro-4, 7-methano-1H-indene- 5-diyl) bis (methyleneiminocarbonyloxy-2, 1-ethanediyl) ester

Table 4 shows the clinical evaluation results of the biological properties. At 4 years recall, little plaque accumulation without gingival inflammation and pocket development were observed on 4 Filtek-Z550 and three Charisma-Diamond restorations (Score 2). The adjacent mucosa of two Filtek-Z550 and two Charisma-Diamond restorations would be entirely healthy after minor removal of mechanical irritations (Score 2). The biological properties of the rest of the restorations in both groups were clinically excellent (Score 1), and again no significant differences were observed between two groups during 4 years ($P > 0.05$).

When the performance of each material was individually evaluated, Cochrane Q-test pointed some significant deteriorations on the esthetic, functional, and biological properties during 4 years in comparison with baseline. Filtek-Z550 restorations started to exhibit slight deviations on surface luster at 4 years whereas the deviations started at 3 years for Charisma-Diamond

Table 2: Clinical evaluation of esthetic properties

Groups	FDI scores	Baseline		1 year		2 years		3 years		4 years	
		Group 1 (*n*=37), *n* (%)	Group 2 (*n*=39), *n* (%)	Group 1 (*n*=37), *n* (%)	Group 2 (*n*=39), *n* (%)	Group 1 (*n*=33), *n* (%)	Group 2 (*n*=35), *n* (%)	Group 1 (*n*=27), *n* (%)	Group 2 (*n*=31), *n* (%)	Group 1 (*n*=27), *n* (%)	Group 2 (*n*=31), *n* (%)
Surface luster	1	37 (100)	39 (100)	37 (100)	36 (92.3)	33 (100)	32 (91.4)	24 (88.9)	25 (80.6)*	20 (74.1)*	22 (71)*
	2				3 (7.7)		3 (8.6)	3 (11.1)	6 (19.4)	7 (25.9)	9 (29)
	3										
	4										
	5										
Surface staining	1	37 (100)	39 (100)	35 (94.6)	34 (87.2)*	31 (93.4)	30 (83.3)*	24 (88.9)	26 (82.8)*	21 (77.8)*	26 (83.9)*
	2			2 (5.4)	5 (12.8)	2 (6.6)	5 (16.7)	3 (11.1)	5 (17.2)	6 (22.2)	5 (16.1)
	3										
	4										
	5										
Margin staining	1	37 (100)	39 (100)	37 (100)	39 (100)	33 (100)	35 (100)	22 (81.5)*	28 (90.3)	15 (55.6)*	22 (71)*
	2							5 (18.5)	3 (9.7)	10 (37.0)	9 (29)
	3									2 (7.4)	
	4										
	5										
Color match and translucency	1	37 (100)	39 (100)	37 (100)	39 (100)	33 (100)	35 (100)	27 (100)	25 (80.6)*	25 (92.6)	25 (80.6)*
	2								6 (19.4)	2 (7.4)	6 (19.4)
	3										
	4										
	5										
Esthetic anatomical form	1	37 (100)	39 (100)	37 (100)	39 (100)	33 (100)	35 (100)	27 (100)	29 (93.5)	26 (96.3)	27 (87)*
	2										2 (6.5)
	3										
	4								2 (6.5)	1 (3.7)	2 (6.5)
	5										

*Significant difference in comparison with baseline according to Cochrane Q-test (P<0.05). FDI=Fédération Dentaire Internationale (World Dental Federation)

Table 3: Clinical evaluation of functional properties

Groups	FDI scores	Baseline		1 year		2 years		3 years		4 years	
		Group 1 (*n*=37), *n* (%)	Group 2 (*n*=39), *n* (%)	Group 1 (*n*=37), *n* (%)	Group 2 (*n*=39), *n* (%)	Group 1 (*n*=33), *n* (%)	Group 2 (*n*=35), *n* (%)	Group 1 (*n*=27), *n* (%)	Group 2 (*n*=31), *n* (%)	Group 1 (*n*=27), *n* (%)	Group 2 (*n*=31), *n* (%)
Fracture of material and retention	1	37 (100)	39 (100)	37 (100)	39 (100)	33 (100)	35 (100)	27 (100)	29 (93.5)	26 (96.3)	29 (93.5)
	2										
	3										
	4								2 (6.5)	1 (3.7)	2 (6.5)
	5										
Marginal adaptation	1	37 (100)	39 (100)	34 (91.9)	38 (97.4)	29 (88.9)	32 (91.4)	22 (81.5)*	26 (82.8)*	19 (70.4)*	22 (71)*
	2			3 (8.1)	1 (2.6)	4 (12.1)	3 (8.6)		5 (17.2)	6 (22.2)	7 (22.5)
	3							5 (18.5)		1 (3.7)	
	4									1 (3.7)	2 (6.5)
	5										
Proximal anatomical form	1	37 (100)	39 (100)	37 (100)	39 (100)	33 (100)	35 (100)	27 (100)	29 (100)	26 (96.3)	22 (71)*
	2										
A. Contact point	3										7 (22.5)
	4									1 (3.7)	2 (6.5)
	5										
Proximal anatomical form	1	37 (100)	39 (100)	37 (100)	39 (100)	33 (100)	35 (100)	27 (100)	29 (100)	26 (96.3)	25 (80.6)*
	2										4 (12.9)
B. Contour	3										

Contd...

Table 3: Contd...

Groups	FDI scores	Baseline		1 year		2 years		3 years		4 years	
		Group 1 (*n*=37), *n* (%)	Group 2 (*n*=39), *n* (%)	Group 1 (*n*=37), *n* (%)	Group 2 (*n*=39), *n* (%)	Group 1 (*n*=33), *n* (%)	Group 2 (*n*=35), *n* (%)	Group 1 (*n*=27), *n* (%)	Group 2 (*n*=31), *n* (%)	Group 1 (*n*=27), *n* (%)	Group 2 (*n*=31), *n* (%)
	4									1 (3.7)	2 (6.5)
	5										
Patient's view	1	37 (100)	39 (100)	37 (100)	39 (100)	33 (100)	35 (100)	22 (81.5)*	29 (93.5)	22 (81.5)*	27 (87.0)*
	2									4 (14.8)	2 (6.5)
	3							5 (18.5)			
	4								2 (6.5)	1 (3.7)	2 (6.5)
	5										

*Significant difference in comparison with baseline according to Cochrane Q-test (P<0.05). FDI=Fédération Dentaire Internationale (World Dental Federation)

Table 4: Clinical evaluation of biological properties

Groups	FDI scores	Baseline		1 year		2 years		3 years		4 years	
		Group 1 (*n*=37), *n* (%)	Group 2 (*n*=39), *n* (%)	Group 1 (*n*=37), *n* (%)	Group 2 (*n*=39), *n* (%)	Group 1 (*n*=33), *n* (%)	Group 2 (*n*=35), *n* (%)	Group 1 (*n*=27), *n* (%)	Group 2 (*n*=31), *n* (%)	Group 1 (*n*=27), *n* (%)	Group 2 (*n*=31), *n* (%)
Periodontal response	1	37 (100)	39 (100)	37 (100)	39 (100)	33 (100)	35 (100)	27 (100)	31 (100)	23 (85.2)*	28 (90.3)*
	2									4 (14.8)	3 (9.7)
	3										
	4										
	5										
Adjacent mucosa	1	37 (100)	39 (100)	37 (100)	39 (100)	33 (100)	35 (100)	27 (100)	31 (100)	25 (92.6)	29 (93.5)
	2									2 (7.4)	2 (6.5)
	3										
	4										
	5										
Oral and general health	1	37 (100)	39 (100)	37 (100)	39 (100)	33 (100)	35 (100)	27 (100)	31 (100)	27 (100)	31 (100)
	2										
	3										
	4										
	5										

*Significant difference in comparison with baseline according to Cochrane Q-test (P<0.05). FDI=Fédération Dentaire Internationale (World Dental Federation)

restorations ($P < 0.05$) [Table 2]. Minor surface stainings started to be seen since 1 year for Charisma-Diamond restorations and at 4 years for Filtek-Z550 restorations ($P < 0.05$). Mild degradations were observed on marginal staining for Filtek-Z550 restorations at 4 years and for Charisma-Diamond restorations at 3 and 4 years ($P < 0.05$). Charisma-Diamond restorations started to exhibit minor deviations at color match and translucency at 3 years ($P < 0.05$). Deviations were also seen on anatomical form of some Charisma-Diamond restorations at 4 years ($P < 0.05$). For marginal adaptation, deviations were started at 3 years both for Filtek-Z550 and Charisma-Diamond restorations ($P < 0.05$) [Table 3]. Proximal anatomical contact and contour form started to change at 4th year in Charisma Diamond group ($P < 0.05$). Patient's view slightly changed at 3 and 4 years for Filtek-Z550 restorations and at 4 years for Charisma-Diamond restorations ($P < 0.05$). Little plague accumulation around 4 Filtek-Z550 and 3 Charisma Diamond restorations without any sing of inflammation in periodontal tissues were also observed at 4 years ($P < 0.05$) [Table 4]. However, except two Filtek-Z550 and one Charisma-Diamond restorations that were partially fractured, all the degradations in both groups were still in clinically acceptable limits.

Discussion

During the last two decades, the use of resin composites for esthetic restorative procedures has increased owing to improvements in adhesive systems and composite resin materials. Compared with indirect restorations, reshaping teeth, and closing diastemas with contemporary direct composite buildups are advantageous, especially in the treatment of healthy teeth wherein a maximal tissue-saving

approach is imperative. In general, composite resin restorations are reported to have promising results with the claim to be strong, to stay in place for many years, and to have excellent esthetic potential which enables to accurately simulate the appearance of normal tooth structure.[9] They also cost much less than equivalent indirect restorations.[1,12] Therefore, this study was planned to evaluate and to compare the clinical performance of two nanohybrid composite resin systems for diastema closure and tooth reshaping.

It's well known that acceptable adhesion to enamel and dentin could be achieved with the etch-and-rinse and two-step self-etch adhesives.[4,13,14] However, etch-and-rinse technique is definitely still the most effective approach to achieve efficient and stable enamel bonding.[15,16] In this technique, acid etching individually exposes hydroxyapatite crystals and resin tags are created within the pits due to *in situ* polymerization of the resin.[15] Bonding to enamel by micromechanical interlocking of resin tags is still considered to be the gold standard where up to 40 MPa is achieved in *in vitro* studies, sometimes even exceeding the cohesive strength of the enamel itself.[17,18] Since direct composite resin build-ups in this study were performed on sound and undamaged enamel surfaces, composite resin systems were applied with their respective etch-and-rinse adhesive systems to achieve efficient and stable bonding to enamel.[15,16]

The hybrid composites were reported to have a better overall performance regarding esthetic properties and fracture than microfilled composites.[19] On this respect, two nanohybrid composite resin systems with different properties, both of which were launched with the claim to have very high esthetic and mechanical properties, were used and compared in the present study. Filtek Z550 is reported to include 82 weight %, 68 volume % surface-modified zirconia/silica fillers and non-aggomerated/non-aggregated surface-modified silica particles, whereas Charisma-Diamond includes 81 weight %, 64 volume % barium aluminum fluoride glass nanofillers. Besides the differences on their filler types, filler loads and concomitant bonding agents; the clinical performance of both nanohybrid composite resin systems were satisfying for esthetic, functional, and biological properties, and there was no significant difference between two materials during 4-year follow-up.

Taking a closer look at the esthetic parameters; all the restorations were clinically either excellent or good for surface luster, surface staining, margin staining, color match, and translucency without need of any correction at the end of 4 years. Peumans *et al*.[20] evaluated the 5 years clinical performance of direct composite buildups for tooth reshaping and reported that only 89% of the restorations were esthetically satisfactory while the remaining restorations required replacement due to severe color mismatch and severe loss of anatomic form. In the current study, although unacceptable deviations that needs to be repaired to improve the anatomical form were observed for 1 (3.7%) Filtek-Z550 and 2 (6.5%) Charisma-Diamond restorations, none of the restorations required to be replaced during 4 years. Furthermore, the rest of the esthetic properties were even better when compared with their results. The diversity of these results might be due to the use of nanotechnology-based modern composites in this study, which are reported to have improved mechanical and esthetic properties.[6,21] Supporting our results, Demirci *et al*.[3] evaluated the 4 years clinical performance of a nano (Filtek Supreme XT) and nanohybrid (CeramX Duo) composite buildups for diastema closure and reported that all the restorations were clinically acceptable for the esthetic criteria assessed.

When it comes to the functional parameter evaluations of the present study, the 4-year survival rates for Filtek Z550 and Charisma-Diamond restorations were 96.3% and 93.5%, respectively. Our results are in accordance with the results of Demirci *et al*.,[3] who reported that the 4-year survival rates for Filtek Supreme XT nano and CeramX Duo nanohybrid composites were 92.8% and 93% when used for diastema closure and teeth recontouring. In another study, Coelho-de-Souza *et al*.[22] retrospectively evaluated the clinical performance of direct anterior composite buildups in vital and nonvital teeth and reported a 95.1% survival rate for vital teeth at the end of 3.5 years. On the other hand, survival rates of the present follow-up investigation are slightly higher than results of some other studies that evaluated teeth reshaping and diastema closure using direct composite buildups.[1,2] Among those, a clinical study evaluated 176 direct composite buildups and obtained a 5-year survival rate of 84.6%,[1] whereas the other study investigated 284 direct composite buildups and obtained a 5-year survival rate of 79.2%.[2] Peumans *et al*.[20,23] also clinically evaluated 87 direct composite buildups to correct tooth form and position in 23 adults and reported a 5-year survival rate of 89%. The use of different dentin bonding agents, composite resin systems and evaluation periods may have contributed to the differences in the results. As the restoration sizes have also been reported to influence the clinical performance of direct composite buildups,[20,23] different restoration sizes on those studies might be another reason for the differences on the survival rates. On the other hand, when we look at the unacceptable restorations, we can

see that only 2 Filtek-Z550 and 1 Charisma-Diamond restorations were partially fractured during 4 years, which required to be repaired. No cases of complete failure were observed which aids for replacement. It becomes evident that repairability is, besides other advantages, the most important factor extending the survival of direct composite resin buildup.[19,22] Since minor fractures and chippings can easily be repaired using the state-of-the-art adhesive repair techniques, and repaired restorations remain in function, functional survival can be increased.[24,25] This is of great benefit to the patients who experience shorter treatment time and lower treatment cost, and it also benefits prognosis of the teeth, which are kept from entering the cycle of repeated restoration.[2,26] Besides, the possibility of instant and minimally invasive repair of composite resins and the broad range of options for changing the shape or color– even after long *in vivo* periods– point to the flexibility of "direct composite resin buildup" approach.[1]

At the end of 4 years, the biological parameters, periodontal response, adjacent mucosa, and oral and general health showed excellent or good clinical results as well. These findings are contrary to the report of Peumans *et al*.,[27] who showed a negative influence of direct composite resin buildups on marginal periodontal health. As previously reported,[28] plaque accumulation on composite resin surfaces is greater than other esthetic restorative materials. In this study, although the margins of the restorations were placed slightly below the gingival crest to obtain a natural appearance, accurate application of composite resin material and polishing of all composite surfaces might reduce their impact on adjacent oral tissues. For this purpose, the clinicians who applied the restorations had a clinical experience of at least 10 years, as handling and modeling of composite resins especially in the esthetic zone requires a long learning curve and training. Besides, for applying a more periodontium friendly approach, the teeth were isolated using cotton rolls because they would allow better visualization, which would aid in relating the restoration contour to the proximal tissues and to avoid any negative effect of rubber dam which is not recommended for direct composite buildups for diastema closure as it obscures the interproximal papilla and limits access to gingival regions.[3,10,29]

In the present study, the most frequent deteriorations were observed on surface luster, surface/margin staining, marginal adaptation, and patient's view for both of the restorative materials according to baseline. Charisma-Diamond restorations additionally exhibited slight degradations on color match and translucency, esthetic anatomical form, and proximal anatomical form. However, all those degradations were within mild-to-moderate limits, and the restorations were still clinically acceptable after 4 years of clinical service.

Survival data and quality outcome of this evaluation implies that direct composite resin buildups with the current nanohybrid composites might be able to fulfill the objectives; superior esthetic and functional characteristics; adequate biological properties; improved subjective and objective appearance of the treated teeth; and acceptable survival time by applying adequate adhesive techniques.

Conclusions

In the present study, the 4-year survival rates of Filtek-Z550 restorations (96.3%) and Charisma-Diamond restorations (93.5%) were found to be favorable and almost equal through which the null hypothesis of the study was supported. Therefore, the following conclusions could be driven;

1. The use of nanohybrid composites, which were used in the present study for diastema closure, might result in high-quality restorations and good medium-term results
2. Direct composite buildups may provide an almost excellent treatment alternative for the esthetic correction and reshaping of anterior teeth n clinical cases, in which a noninvasive treatment approach is indicated.

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Conflicts of interest

There are no conflicts of interest.

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