Original Article

EVALUATION OF THE CLINICAL PERFORMANCE OF DIFFERENT BULK-FILL COMPOSITES ACCORDING TO CLINICAL EVALUATION CRITERIA

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ABSTRACT

This study aimed to evaluate the clinical performance of three bulk-fill composites with a conventional composite of microhybride according to two different clinical evaluation criteria. 120 restorations were performed. A doctor restored the randomly selected 30 teeth with the selected 4 materials (GC Posterior-Group 1, Tetric Evo Ceram Bulk Fill-Group 2, Sonic Fill System-Group 3, and Filtek Bulk Fill-Group 4). Patients were called to the clinic for 3, 6, 9, and 12 months. Using FDI and USPHS clinical evaluation criteria, Two physicians scored each restoration. For each criterion, intra-group and inter-group data were analyzed using the IBM SPSS Statistics Version 22 packet program. After one year of evaluation, Surface polish, color stability, and surface structure of Sonic Fill System and Filtek Bulk Fill composites were found when compared with baseline scores ($p < 0,05$). The scores showed a significant difference from the baseline values ($p < 0.05$) when the patients' views were evaluated for GC Posterior and Filtek Bulk Fill composites. Postoperative sensitivity decreased with time in all composite restorations ($p < 0.05$). According to both FDI and USPHS criteria, all of the restorative materials showed satisfactory clinical performance. The sensitivity of marginal discoloration was found to be higher in FDI criteria than in USPHS criteria. Much more evaluations are necessary for the long-term clinical performances of bulk-fill composite materials.

Key words: Bulk fill composite, Nanohybrid composite, Clinical evaluation criteria, Clinical evaluation.

Introduction

Restorative treatments aim to restore the lost dental structure with appropriate materials. The treatment of dental caries results in a restoration structure [1, 2]. In the foundation, composite and amalgam are the two types of material used. Indications for the material vary according to the location of the tooth, the forces loaded on it, and the para-functional habits and oral hygiene of the patient. Current developments in composite restorations have broadened the areas of use [3].

For the complete polymerization of composite resins hardened with light that is generally preferred during the restoration of cavities, it is necessary to use a certain thickness. The maximum thickness defined for this has been determined as 2mm [4]. Bulk-fill composites, which have similar content to conventional resin-based composites, have recently come into clinical use. These are materials in layers 4 or 5mm thickness that can be polymerized in a single step. Thus, although the treatment process is more rapid and simple, the contamination risk is overcome during the placement of the layers [5, 6].

Polymerization with a light source in a single session entails problems in greater thicknesses of bulk-fill composites, such as polymerization shrinkage stress and providing sufficient polymerization. To overcome similar problems in these composites, the organic matrix has been modified, the monomer size has been increased, and although there are differences between manufacturers, inorganic fillers have been added. High-branching methacrylate, aromatic UDMA, and hydroxyl free BisGMA have been added to the organic part, and ytterbium trifluoride, barium glass, and zirconium particles to the inorganic filler content [5]. However, composite elements such as BisGMA, UDMA, TEGDMA, and EBPDMA monomers are found in the organic structures in the base.

Bulk-fill composites are containing patented urethane dimethacrylate with photoactive groups, which aim to control polymerization kinetics (eg, Smart Dentin Replacement (SDR) technology). Ivocerin starter has been reported to have been added to accelerate and increase polymerization depth with Tetric Evo Ceram as an additional camphorquinone/amine starter. In other bulk-fill materials, no difference has been reported in respect of starter systems. A simple method used by all manufacturers to increase polymerization depth is the reduction of the amount of filler with an increase in translucency [7].

Bulk-fill composites can be classified according to viscosity as low and high viscosity. As materials with low viscosity have lower mechanical properties, the restoration must be

finished using a posterior composite in the uppermost layer. Materials with high viscosity can be polymerized without the need for a different composite in the final layer [5, 8].

Evaluations of the physical and mechanical properties in newly-developed restorative materials such as decrease in the microhardness of a restorative material may lead to its breakdown or deterioration, can be determined in in-vitro studies by fixing the factors beyond the conditions studied. With in-vitro studies, an idea can be obtained about several properties of the material without it being used within the mouth. However, as the main aim of restorations is for use within the mouth, several different factors can affect, such as micro-organisms, chemical agents, and oral fluids, primarily saliva. Therefore, after sufficient in-vitro studies, materials must be processed in a series of in-vivo studies [9].

For a clinical study to be meaningful and to be able to provide standardization of follow-up, internationally accepted criteria must be used. The International Modified Ryge Criteria (USPHS-Modified United States Public Health Service), FDI (World Dental Federation) criteria and CDA (California Dental Association) criteria have been defined, and are widely used for the evaluation of restorations.

The evaluation of the clinical acceptability of many restorations is based on the degree of success of restorations with the USPHS criteria. Criteria such as color compatibility, edge discoloration, retention, anatomic form, edge compatibility, surface structure, secondary decay, and postoperative sensitivity, which are of clinical importance for dental restorations, have been designed for evaluation. According to the modified USPHS criteria, defined characteristics in the restoration are evaluated with Alpha, Bravo, Charlie scores according to the evaluation of the patient, radiographs, and visual examination with assistive manual instruments. These scores are defined as Alpha indicating the best score and Charlie the worst [10, 11].

The FDI criteria were published in 2007, defined as for the direct and indirect evaluation of restorations. The evaluation of restorations is classified under 3 main headings as aesthetic, functional, and biological criteria, and by separation into sub-groups within each group. The final points of the 3 main categories are determined by the scores of the sub-categories and considering the worst scores of the group. Scoring is applied from 1 to 5 during evaluation. In the evaluation of these criteria, scores 1, 2, and 3 indicate that the restoration is clinically sufficient, 4 points indicate that it is clinically insufficient but can be repaired, and a score of 5 indicates that it is completely clinically insufficient. Thus results are obtained as to whether the restoration is acceptable or unacceptable, and if it is unacceptable, whether or not it can be repaired. Those which can be repaired are defined as partially successful and those which can not be repaired as completely unsuccessful [12].

This study aimed to compare and evaluate the clinical characteristics of different bulk-fill composites with conventional composites used in the restoration of interface caries.

Materials and Methods

Patient selection

This study was planned as an in-vivo study within the framework of the defined criteria. Before the study, approval was granted by the Local Ethics Committee of the Dentistry Faculty of Dicle University (decision no: 2017/8). The study was conducted in the Restorative Dental Treatment Clinic of Dicle University. Informed consent was obtained from all the patients included in the study.

From a total of 120 posterior teeth with interface caries, 30 were selected at random to form the control group and the remaining 90 teeth with interface caries formed the study group.

Before treatment, radiographic and clinical evaluations were made of both groups. Group 1 (control group) was applied with a clinically accepted universal composite (Gradia Direct Posterior/Gradia -DP). Group 2 was applied with bulk-fill composite with Ivocerin starter added to camphorquinone (Tetric Evo Ceram Bulk-Fill/Ivoclar Vivadent). Group 3 was applied with a bulk-fill material placed in the cavity with a sonic method (SonicFill 2Bulk-Fill/Kerr). Group 4 was applied with a bulk-fill composite material with a camphorquinone starter (Filtek Bulk-Fill/3M ESPE). The selection of the restorative material to be applied to the teeth was determined randomly.

Inclusion criteria

The patients included in the study were those who provided informed consent, had good oral hygiene, were open to receiving information about dental caries and the benefits of restoration, agreed to attend follow-up examinations at certain intervals, had at least one interface caries, that the decay could be restored was confirmed clinically and radiographically, and had contact between the teeth and opposite teeth.

Clinical protocol

The vitality of the teeth to which the restoration was to be applied was evaluated using a digital vitalometer (Digitest II, Parkell Inc, USA). Local anaesthetic was applied before the procedure or as required during the procedure, taking into consideration the depth of the decay and the pain threshold of the patient. In the tooth with the decay, a cavity was opened with a diamond drill and fissure burr with the tooth surface underwater cooling with an aerator. The cavity was cleaned with a steel drill with a slowly rotating micromotor. This process was continued until there was no decay remaining. The cavity was then washed with water and dried with sterile cotton pellets. Cotton rolls and saliva absorbers were used to provide isolation. The depth of the

opened cavity was evaluated when the procedure was finished, and in a deep cavity, calcium hydroxide was applied to the deepest point to form a superficial necrosis layer and repair dentin. The cavity layer above was covered with the material. A sectioned matrix band (Palodent V3/Dentsplay, USA) was applied to the cavity with a wedge of appropriate width, and after application of the bonding agent, the relevant composite material was applied to the cavity following the manufacturer's instructions.

Group 1; After preparation of the teeth, the defined self-etch adhesive system (Clearfil S^3 Bond- Kuraray, Sakazu, Kurashiki, Okayama, Japan) was applied to the cavity wall in accordance with the manufacturer's instructions in the guide to the material, using a brush for 10 secs then after waiting 20 secs isolated from blood and saliva, it was dried for a further 5 secs with air spray and another thin layer of the bond was applied. Polymerization was applied with an LED light source at 400-550 nm wavelength for 10 secs. Using the incremental layering technique, Gradia Direct Posterior composite (GC Corp, Tokyo, Japan) was applied to the cavity in 2mm layers and each layer was polymerized with light for 20 secs.

Group 2; After opening the cavity and completing the adhesive process in the same manner as for Group 1, Filtek bulk-fill (Filtek Bulk-Fill/3M ESPE) single-use capsule material was placed in an application gun and was applied to the cavity in a single layer of 4-5mm. During placement, the tip of the single-use capsule was placed close to the deepest point, and care was taken when withdrawing. Thus it was aimed to avoid unwanted gaps in the composite.

Group 3; Tetric Evo Ceram Bulk-Fill composite (Ivoclar Vivadent Schaan, Liechtenstein) was applied to the prepared cavity in 4mm layers and was condensed and shaped with appropriate manual instruments. Then polymerization was applied with an LED light source at 400-550 nm wavelength for 20 secs to the occlusal, buccal and lingual surfaces.

Group 4; Sonic 2 Bulk-Fill was applied with an appropriately shaped handpiece adapted for the unit. The tips of the single-use composite were placed on the handpiece as defined in the instructions. Placement of the material, which has a level of application from 1 to 5 was achieved in all the cavities at level 3 at the standard rate at a thickness of 4-5mm. Then, polymerization was applied with an LED light source at 400-550 nm wavelength for 20 secs to the occlusal, buccal and lingual surfaces.

When polymerization was completed, the finishing and polishing procedures of the restorations were applied first with surface smoothing using fine-grained diamond burrs with yellow bands together with water cooling. Occlusion compatibility of the restorations was obtained and composite sandpaper was used on the interfaces. Then the polishing procedures were completed using Arkansas stone, yellow composite varnish rubbers, and polymax-impregnated varnish felt (TDV Dental), respectively. The edges of the restoration were checked very often with a fine-tipped probe. Following the procedures, oral hygiene education was given to patients by explaining dental care related to oral hygiene health and it was aimed to raise awareness in the patients.

Clinical evaluation

Patients were requested to attend the clinic for evaluations at 3, 6, 9, and 12 months after the application of the restoration. Evaluations of the restorations were made according to the FDI criteria together with the modified USPHS criteria. The teeth with the restorations were dried with pressurized air spray and isolated with cotton rolls, then examined with a mirror and probe. When necessary, radiographs were taken and the vitalometer device was used.

The scoring of the FDI criteria was as follows: 1=the restoration is excellent or there is no clinical deficiency, 2=excellent if sufficient characteristics can be obtained after a small change, 3=can be used clinically but there are 1 or more insufficient characteristics, 4=the restoration does not have sufficient characteristics but can be used clinically with repair, 5=completely insufficient clinical characteristics and there is an indication for change.

If there was the loss of retention in the restoration, it was only evaluated in respect of this criteria without examination of the other criteria, and it was not included in subsequent evaluations. For restorations scored as 4 points, evaluations were terminated after repairing. In localized defects, conditions that can be repaired include the addition of filling material to small openings and fractures, changing a part of the restoration, or when discolored areas are limited.

Statistical analysis

Data obtained in the study were analyzed statistically using IBM SPSS Statistics vn 22 software. In the evaluation of the FDI criteria, the Shapiro Wilk test, Friedman's Two-Way ANOVA, and the Kruskal Wallis H-test were used. Pearson Chi-square analysis and the Wilcoxon test were used in the evaluation of the USPHS criteria. A value of $p<0.05$ was considered statistically significant.

Results and Discussion

All the patients attended the follow-up appointments, but 1 patient in Group 3 presented in the 5th month with complaints of severe night-time pain and was referred to the endodontics clinic with the indication for canal treatment. Therefore, the evaluation of Group 3 was completed with 29 restorations and the overall total was 119.

FDI criteria findings

The results obtained from the evaluations of the restorations with the FDI criteria were compared within and between the groups and analyzed statistically.

The statistically significant results of the inter-group

comparisons in **Table 1** and of the intra-group evaluations are shown in **Table 2**.

Table 1. The statistically significant results of the inter-group comparisons.

P values Criteria	Surface luster				Surface Staining			
	3 months (mths)	6 mths	9 mths	12 mths	3 mths	6 mths	9 mths	12 mths
1-2 Groups	0,272	0,272	p>0,05 p=0,052	p>0,05 P=0,649	1	1	P>0,05 P=0,221	P>0,05 P=0,244
1-3 Groups	**0,015**	**0,015**			1	1		
1-4 Groups	**0,014**	**0,014**			0,471	0,471		
2-3 Groups	1	1			0,154	0,154		
2-4 Groups	1	1			1	1		
3-4 Groups	1	1			**0,041**	**0,041**		
	Margin Staining				Colour match and translucency			
	3	6	9	12	3	6	9	12
1-2 Groups	0,06	p>0,05 p=0,111	0,397	p>0,05 p=0,052	1	1	1	P>0,05 P=0,141
1-3 Groups	**0,012**		**0,027**		0,255	0,255	0,436	
1-4 Groups	**0,011**		0,101		1	1	1	
2-3 Groups	0,511		1		0,072	0,072	**0,049**	
2-4 Groups	0,508		1		1	1	1	
3-4 Groups	1		1		**0,017**	**0,017**	**0,049**	
	Patient's view							
	3	6	9	12				
1-2 Groups	**0,025**	**0,024**	P>0,05 P=0,067	P>0,05 P=0,070				
1-3 Groups	0,082	**0,028**						
1-4 Groups	0,176	**0,001**						
2-3 Groups	1	1						
2-4 Groups	1	1						
3-4 Groups	1	1						

- Values with p <0.05 as a result of statistical evaluation are marked with dark bold.
- In this table, there are results obtained by examining the restorations according to FDI criteria.

Table 2. The statistically significant results of the intra-group

GROUPS	1. GROUP					
Criteria/ Scores	'P' VALUES BETWEEN MONTHS					
	3-6	3-9	3-12	6-9	6-12	9-12
Surface Lustre	p= 0,392 p > 0,05					
Staining	p= 0,194 p > 0,05					
Patient's view	0,18	**0,043**	**0,043**	0,083	0,083	1,00
Post operative sensitivity	**0,005**	**0,006**	**0,006**	**0,046**	**0,046**	1,00
	2. GROUP					
Surface Lustre	p= 0,392 p > 0,05					
Staining	p= 0,121 p > 0,05					
Patient's view	p= 0,392 p > 0,05					

Post operative sensitivity	**0,004**	**0,010**	**0,018**	0,317	0,705	0,317
			3. GROUP			
Surface Lustre	1,00	0,157	**0,014**	0,157	**0,014**	**0,046**
Staining	1,00	0,083	**0,025**	0,083	**0,025**	0,157
Patient's view			p= 0,733 p > 0,05			
Post operative sensitivity			p= 0,091 p > 0,05			
			4. GROUP			
Surface Lustre	1,00	0,317	**0,014**	0,317	**0,014**	**0,025**
Staining	1,00	0,157	**0,025**	0,157	**0,025**	0,083
Patient's view	**0,046**	**0,046**	**0,046**	1,00	1,00	1,00
Post operative sensitivity	**0,001**	**0,001**	**0,001**	0,317	0,317	1,00

- Values with p <0.05 as a result of statistical evaluation are marked with dark bold.
- In this table, there are results obtained by examining the restorations according to FDI criteria.

Modified USPHS criteria findings

Intra-group evaluations

The statistically significant results obtained from the analyses are shown in **Table 3**.

Table 3. The Statistically Significant Results for İntra-Groups Evaluations with the USPHS Criteria.

The Statistically Significant Results for İntra-Groups Evaluations with the USPHS Criterias			
Criteria	**Groups**	**3. month**	**P values**
Color Match	4. Group	12. month	0,014
Surface Texture	3. Group	12. month	0,025
	4. Group	12. month	0,014
Postoperative sensitivity	1. Group	6. month	0,046
		9. month	0,014
		12. month	0,014
	2. Group	9. month	0,046
	3. Group	9. month	0,046
		12. month	0,046
	4. Group	6. month	0,008
		9. month	0,005
		12. month	0,005

- Only values that are statistically significant (p <0.05) are indicated in this table.

In the Filtek bulk-fill group, a statistically significant differentiable was determined between the color compatibility at 3 and 12 months. Of those with Alpha color compatibility at 3 months, at 12 months, 80% of these were Alpha and 20% Bravo (p=0.014).

In the Sonic-Fill System, a statistically significant difference was determined between the surface structure at 3 and 12 months (p=0.025). Of those with Alpha surface structure at 3 months, at 12 months, 82.76% of these were Alpha and 17.24 % Bravo.

In the Filtek bulk-fill group, a statistically significant difference was determined between the surface structure at 3 and 12 months (p=0.014). Of those with Alpha surface structure at 3 months, at 12 months, 80% of these were Alpha and 20% Bravo.

In the GC group, a statistically significant difference was determined between the postoperative sensitivity at 3 and 6 months (p=0.046). Of those with Alpha postoperative sensitivity at 3 months, 100% were Alpha at 6 months. Postoperative sensitivity at 3 months was determined as 40% Alpha and 60% Bravo.

In the GC group, a statistically significant difference was determined between the postoperative sensitivity at 9 and 12 months (p=0.014). Of those with Alpha postoperative sensitivity at 3 months, 100% were Alpha at 9 months and 12 months. Of those with Bravo postoperative sensitivity at 3 months, 60% were Alpha and 40% Bravo.

In the Tetric Evo Ceram Bulk-Fill group, a statistically significant difference was determined between the postoperative sensitivity at 3 and 9 months (p=0.046). Of those with Alpha postoperative sensitivity at 3 months, 100% were Alpha at 9 months. Of those with Bravo postoperative sensitivity at 3 months, 66.67% were Alpha and 33.33% Bravo.

In the Sonic-Fill System group, a statistically significant difference was determined between the postoperative sensitivity at 3 months and 9 and 12 months (p=0.046). Of those with Alpha postoperative sensitivity at 3 months, 100% were Alpha at 9 months and 12 months. Of those with Bravo postoperative sensitivity at 3 months, 66.7% were Alpha and 33.33% Bravo.

In the Filtek bulk-fill group, a statistically significant difference was determined between the postoperative sensitivity at 3 and 6 months (p=0.008). Of those with Alpha postoperative sensitivity at 3 months, 100% were Alpha at 6 months. Of those with Bravo postoperative sensitivity at 3 months, 77.78% were Alpha and 22.22% Bravo.

In the Filtek bulk-fill group, a statistically significant difference was determined between the postoperative sensitivity at 3 months and 9 and 12 months (p=0.005). Of those with Alpha postoperative sensitivity at 3 months, 100% were Alpha at 9 months and 12 months. Of those with Bravo postoperative sensitivity at 3 months, 88.89% were Alpha and 11.11% Bravo.

Inter-group evaluations

The significant results of the statistical analyses are shown in **Tables 4 and 5**.

Table 4. According to Usphs criteria, p values are found according to the evaluation results inter-groups at 3, 6, 9, and 12 months.

USPHS Criteria	'p' Values			
	3. Month	6. Month	9. Month	12. Month
Color Match	**0,027**	0,125	0,48	0,74
Marginal Discoloration	0,168	0,508	0,192	0,138
Retention	-	-	1,00	1,00
Anatomical Form	0,334	0,761	0,761	0,515
Marginal Adaptation	0,246	0,189	0,189	0,395
Surface Roughness	**0,017***	0,074	0,519	0,697
Secondary Caries	-	-	-	1,00
Postoperative sensitivity	0,558	0,484	0,58	0,611

- Values with p <0.05 as a result of statistical evaluation are marked with dark bold.
- In this table, there are results obtained by examining the restorations according to FDI criteria.

Table 5. Alpha percentage values of groups at times showing significant p values.

USPHS Criteria	Alpha Value Percentages of Groups				Significant P Values
	1. Group	2. Group	3. Group	4. Group	
Color Match-3. month	**%93,33**	%93,33	%79,31	%100	**0,027**
Surface Roughness-3. month	**%83,33**	%93,33	%100	%100	**0,017**

- Values with p <0.05 as a result of statistical evaluation are marked with dark bold.
- In this table, there are results obtained by examining the restorations according to FDI criteria.

The developing in the bulk fill materials may be useful when restoring posterior cavities where procedural time is of concern and technique sensitive to restorations [13].

The USPHS criteria, which are useful in the evaluation of the clinical success of restorations, are the most frequently used method in clinical studies. However, their sensitivity to exposing differences is lower compared to other criteria. In reaching this conclusion, the effects of all dental factors must not be ignored [14]. In a study by Paula *et al.* which examined the results of a 12-month randomized, clinical study evaluating adhesion success, it was concluded that the FDI evaluations were more sensitive to small changes in clinical results than the USPHS criteria [15]. De Almedia Durao *et al.* reported that the percentage of the acceptable scores was significantly higher for the USPHS criteria [16]. In a 36-month follow-up study, Loguercio *et al.* examined restorations applied with self-etch and total-etch systems and concluded that the FDI criteria were more sensitive than USPHS criteria in respect of marginal discoloration and marginal compatibility [17]. In the current study, it was observed that the FDI criteria provided more sensitive results in the marginal discoloration findings.

Akalin *et al.* applied high-viscosity, nano-hybrid, bulk-fill composite to Grade II cavities with sonic activation and concluded that acceptable success was observed in restorations after a 2-year follow-up. However, there was seen to be a degradation in comparison with the initial restoration in the first 6-month period in respect of color compatibility and translucency [18]. Karaarslan *et al.* was evaluate the clinical performance of two bulk-fill composite resins in Class II cavities for up to twenty-four months and view were statistically significant differences between the three restorative resins in terms of color match parameter [19]. As a result of the clinical study of balkaya *et al.* with bulk fill composites found that for color match there was statistically there was no statistically significant difference between the bulk fill composite and conventional composite [20]. In the current study, similar discoloration findings were seen at 12 months compared with the 3 and 6-month values in restorations applied with Filtek Bulk-Fill composite and Sonic Fill System.

In a study by Barutcugil *et al.*, the color change was evaluated in vitro in nano-hybrid resin composite and 3 bulk-fill composites, and it was observed that in contrast to the increase in color change over time in bulk-fill composites, the color change in nano-hybrid composite stabilized after 1 week [21]. Yazıcı AR *et al.*. found an increase in marginal discoloration over time in conventional composite at the six year evaluation [22]. It is known that coloring can become lighter when fillers remain without polymerization as there are more total surface areas per unit of fillers in the content of nanofilm composites [23]. Therefore, the discoloration over time of Filtek Bulk-Fill composite that has a nanofil structure with Sonic Fill composite, which is in a nano-

hybrid structure, is a result that can be expected compared to GC posterior composite, which is a micro-hybrid composite.

Canali *et al.* evaluated the restorations of 89 cervical lesions without caries in a clinical study and concluded that after 1 year, 3.3% of restorations made with Filtek Bulk Fill composite may not be acceptable [24]. In addition to other study Hardman *et al.*. evaluated to assess the Fast-Modelling Bulk Technique (FMBT) versus the Composite-Up Layering Technique (CULT) in posterior cavities in the study. This study showed the occurrence of discoloration was higher with CULT compared to FMBT [25]. At the end of a 10-year study by Heck *et al.*, in which restorations made with Tetric Ceram and Quixfill Bulk-Fill composite were evaluated, no noticeable difference was reported in Class I restorations while there was observed to be deterioration in the anatomic form of Class II restorations [26]. Van Dijken *et al.* compared Ceram X mono used with the layering technique and Ceram X mono placed as the final layer with SDR placed with the bulk-fill technique and reported that in the 5-year clinical follow-up, there was no significant difference in the evaluation of anatomic form in contrast to the others [27]. Similarly, Atabek *et al.* and Akalin *et al.* found no significant difference as a result of clinical studies made with Sonic Bulk-Fill composites [18, 28]. A one year study by Almedia Durao *et al.*, For the anatomic form category, significant differences were observed between the Tetric Evo Ceram Bulk Fill restoration group and the other resins at baseline [16]. In the current study, no significant result was obtained for the two criteria in the 1-year evaluation. When the duration of previous studies is taken into consideration, while different results have been reported in the evaluations of long-term studies, no significant differences have been observed in shorter-term studies.

As bulk-fill composites shorten the duration of treatment, this is thought to result in patient satisfaction during the process. In addition, when the surface characteristics are taken into consideration according to the filler content of the composites used, those with nanofil filler have a smoother surface and this is known to be able to be protected for a longer time [29]. Suneelkumar C. *et al.* follow up that restored with the bulk fill composite either bulk fill techinique or incremental techique at one years. As a result of this study, no significant difference was found in terms of patient view [30]. Surface properties during function are known to affect the opinion of the patient.

Postoperative sensitivity is a subjective finding and can be affected by many factors ranging from the patient's pain threshold, the distance of the cavity from the pulp, the procedure selected, whether or not the restoration and adhesives are applied with appropriate methods, to the adequacy of isolation. In a 12-month study, Bayraktar *et al.* evaluated 4 composites with USPHS criteria, and Bravo scores were applied to 3 restorations at 1 week and 3 months for Clearfil Photo Posterior composite, to 1 restoration at 1 week, 6, 9, and 12 months and 2 restorations at 1 and 3 months for Filtek bulk-fill flow and Filtek P60 composite, and 1 restoration at 1 week and 3 months for Tetric Evo Ceram Bulk-Fill and Sonic Fill composites. Findings of postoperative sensitivity were not determined in the other months [31].

Hickey *et al.* evaluated findings of postoperative sensitivity in hybrid and bulk-fill composite restorations in a clinical study and reported that bulk-fill composites in Class I cavities caused more sensitivity during chewing. However, the sensitivity reduced over time and was observed to be short-lived [32]. Tardem *et al.* did study that there were only in 7.40% different patients had postoperative sensitivity besides this pain did not show over 48 hours. They showed the restorative technique (incremental vs bulk), the presentation mode (syringe vs capsule) the adhesive strategy (etch-and-rinse vs self-etch) did not affect the risk of postoperative sensitivity [33]. In the current study, the finding of postoperative sensitivity was observed to reduce over time.

In a 12-month clinical follow-up of the comparison of Tetric Evo Ceram and Tetric Evo Ceram Bulk-Fill composites, no findings of postoperative sensitivity were observed in any restorations [34]. In a study by Unemori *et al.*, there was observed to be greater postoperative sensitivity in deep cavities compared to superficial and moderate depth cavities. The main reason for sensitivity in all the groups of the current study was that deep cavities of at least 4-5mm were formed to be able to be included in the study. The pain mechanism occurs with increasing dentin canals and odontoblast extensions in the region close to the pulp. Mechanoreceptor nerves are located in these dentin canals and pain occurs as a result of fluid movement because of the interventions such as the cuts made during the preparation and restoration procedure, the heat formed, drying, and changes in pressure [35].

In a study by Canali *et al.* which evaluated restorations of cervical lesions without caries, although 2 restorations had clinically acceptable scores, Filtek Supreme Ultra Universal composite exhibited greater surface smoothness compared to Filtek Bulk-Fill composite [24]. In a 10-year study by Heck *et al.*, teeth treated with hybrid composite and bulk-fill composite were examined and while no significant difference was found in Class I cavities for Quixfill composite, significant changes were observed in Class II cavities in respect of surface structure [26]. In a one-year study by Ehlers *et al.*, the only statistically significant difference bulk fill materials between the evaluated materials was found in surface roughness [36].

Conclusion

The results of this study showed that the clinical success of all the materials was at a sufficient level according to the FDI and the USPHS criteria. Sensitivity of the FDI criteria to marginal discolouration was found to be higher than that of

the USPHS criteria. At the end of the 1-year study period, it was concluded that the composites used in the study showed sufficient clinical properties and could be used in routine treatments. Nevertheless, there is a need for further long-term clinical studies of bulk-fill composites.

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