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A Two-year Clinical Comparison of Three Different Restorative Materials in Class II Cavities

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Clinical Relevance

Both bulk-fill and conventional composite resins showed a clinically successful performance in Class II restorations over a two-year period, unlike the high-viscosity glass ionomer.

SUMMARY

Objectives: The aim of this clinical study was to evaluate the clinical performance of Class II restorations of a high-viscosity glass ionomer material, of a bulk-fill composite resin, and of a microhybrid composite resin.

Methods and Materials: One hundred nine Class II restorations were performed in 54 patients using three different restorative materials: Charisma Smart Composite (CSC; a conventional composite resin), Filtek Bulk Fill Posterior Restorative (FBF; a high-viscosity bulk-fill composite), and Equia Forte Fil (EF; a high-viscosity glass ionomer). Single Bond Universal adhesive (3M ESPE, Neuss, Germany) was used for both conventional and bulk-fill composite resin restorations. The restorations were evaluated using modified US Public Health Service criteria in terms of retention, color match, marginal discoloration, anatomic form, contact point, marginal adaptation, secondary caries, postoperative sensitivity, and surface texture. The data were analyzed using the chi-square, Fisher, and McNemar tests.

Results: Eighty-four restorations were evaluated at two-year recalls. There were clinically acceptable changes in composite resin restorations (FBF and CSC). In addition, no statistically significant difference was observed between the clinical performances of these materials in terms of all criteria ($p>0.05$). However, there was a statistically significant difference between the EF group and the FBF and CSC groups in all parameters except for marginal discoloration, secondary caries, and postoperative sensitivity ($p<0.05$).

Conclusions: The tested bulk-fill and conventional composite resins showed acceptable clinical performance in Class II cavities. However, if EF is to be used for Class II restoration, its use should be carefully considered.

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INTRODUCTION

Direct restorations have been widely employed to restore posterior teeth because of their low cost, less

need for the removal of sound tooth substance when compared with indirect restorations, and acceptable clinical performance.[1–3] Recently, tooth-colored direct restorative materials have become very popular with advances in adhesive technology, the development of new dental materials, and increasing esthetic demands. However, there is still uncertainty about which is the ideal material for use in the restoration of posterior teeth in terms of long-term clinical success.

Composite resins have commonly been used for posterior restoration because of their acceptable esthetic qualities and their improved mechanical properties and because they allow more conservative cavity preparation design.[4,5] The main challenge with regard to the use of composite resins is polymerization shrinkage. This might cause negative results such as poor marginal adaptation, marginal discoloration, white line formation around the restoration, tubercule fractures, microleakage, secondary caries, and postoperative sensitivity.[6,7] Furthermore, conventional composite resins commonly need an incremental placement technique to avoid depth-of-cure limitations and to overcome polymerization shrinkage stress.[8,9] This placement technique has some drawbacks, such as voids remaining and contamination risk between layers, difficulty in the placement of layers in small cavities, and increased application time.[8,10] To overcome these problems, a new material class referred to as "bulk-fill composite resins" has been developed. It is claimed that bulk-fill composite resins can be polymerized up to 4-mm thickness in a single step without adversely affecting polymerization shrinkage, the adaptation of the cavities, and the degree of conversion during application. They also exhibit less polymerization shrinkage than conventional composite resins.[11]

Glass ionomer cement (GIC) can also be used as an alternative to composite resins in the conservative restoration of posterior caries lesions. GIC has some advantages such as physicochemical adhesion to tooth tissues, fluoride release, biocompatibility, low shrinkage, low marginal leakage, anticaries properties on the restoration edges, and increased remineralization in adjacent proximal caries.[12,13] However, conventional GIC also has disadvantages such as low fracture and abrasion resistance, inadequate color stability, moisture sensitivity, and poor esthetic properties. Some of these disadvantages weaken the physical properties of the material and restrict its use in areas exposed to intensive chewing forces.[14] In recent years, to reduce the moisture sensitivity of GIC in the early stages of hardening, to increase their abrasion resistance, and to enable them to be used in areas exposed to chewing forces, the materials have been strengthened by changing the powder/liquid ratio, particle size, and distribution; as a result, highly viscous glass ionomer cement (HVGIC) has been presented to the market.[14,15] The manufacturer suggests that these materials should be applied with surface-coating resins.[16] The application of surface-coating resins to the GIC surface enhances the surface brightness of the material; prevents the reduction in translucency of the material over time; fills the gaps caused by the material, finishing processes, and surface irregularities in such a way as to provide a smooth surface; reduces moisture sensitivity in the early stages of hardening; increases the resistance to fracture and abrasion; and improves mechanical properties.[16]

In the literature, several studies have compared the clinical performances of conventional composite and high-viscosity glass ionomer or conventional composite and bulk-fill composite, but to the best of our knowledge, this is the first study to compare the clinical performances of a high-viscosity glass ionomer and a bulk-fill composite resin. For this reason, the aim of this clinical study was to compare the clinical performances of a bulk-fill composite resin, a microhybrid composite resin, and a high-viscosity glass ionomer in Class II cavities using modified US Public Health Service (USPHS) criteria. The null hypothesis of this study was that there would be no difference between the two-year clinical performances of composite resin materials (conventional and bulk-fill) and HVGIC in Class II cavities.

METHODS AND MATERIALS

Before conducting the study, the research protocol was approved by the Faculty of Medicine Ethics Committee, Erciyes University, Kayseri, Turkey (approval 2017/44). In this randomized controlled clinical study, an HVGIC (Equia Forte Fil, GC, Tokyo, Japan), a bulk-fill composite resin (Filtek Bulk Fill Posterior Restorative, 3M ESPE, St. Paul, MN, USA), and a microhybrid composite resin (Charisma Smart Composite, Heraeus Kulzer, Hanau, Germany) were compared. The materials, compositions, and batch numbers are given in Table 1.

Study Design and Patient Selection

Patients attending our clinic for routine dental care were examined clinically and radiographically using bite-wing radiography. In this study, 80 patients

Table 1: *Materials, Compositions, and Batch Numbers*

Material and Manufacturer	Batch	Composition
Charisma Smart Composite, Heraeus Kulzer GmbH, Hanau, Germany	010501A	Bis-GMA, barium aluminum fluoride glass, silicon dioxide
Filtek Bulkfill Posterior Restorative, 3M-ESPE, St. Paul, MN, USA	N651351	Aromatic dimethacrylate (AUDMA), urethane dimethacrylate (UDMA), and 1,12-dodecane dimethacrylate (DDMA) Zirconia/silica and ytterbium trifluoride filler
Equia Forte Fil, GC, Tokyo, Japan	150213B	Powder: 95% strontium fluoro alumino-silicate glass, 5% polyacrylic acid Liquid: 40% aqueous polyacrylic acid Equia Forte coat: 40%-50% methyl methacrylate, 10%-15% colloidal silica, 0.09% camphorquinone, 30%-40% urethane methacrylate, 1%-5% phosphoric ester monomer
Single Bond Universal, 3M ESPE, Neuss, Germany	620318	10-MDP phosphate monomer, Vitrebond, copolymer, HEMA, Bis-GMA, dimethacrylate resin, silane, ethanol, water

were assessed for eligibility for participation, and 26 patients were excluded, either because they did not meet all the inclusion criteria or because they did not agree to attend follow-up visits (Figure 1). A total of 54 patients satisfying the inclusion criteria was selected. The inclusion criteria for the selection of patients for the study were as follows: 1) the patient had no systemic disease, 2) the patient was older than 18 years, 3) the patient had good periodontal status, 4) the teeth to be restored were vital, 5) the teeth to be restored had proximal contacts on both mesial and distal surfaces and were in occlusion with the antagonist teeth, and 6) the teeth had Class II caries lesions in the external and middle third of dentin thickness as determined radiographically. The exclusion criteria were as follows: 1) the existence of xerostomia and bruxism; 2) absence of adjacent and antagonist teeth; 3) extremely poor oral hygiene, severe or chronic periodontitis; 4) pregnant or lactating women; 5) teeth with any restoration, endodontic treatment, or periodontal and periapical pathology; and 6) patients who were undergoing orthodontic treatment. The volunteers participating in the study were informed about the research protocol and possible complications. Finally, an informed consent form was read and signed by the patients.

Restorative Procedures

In this study, 109 teeth in 54 patients (31 female, 23 male) were randomly restored by an experienced operator using three different restorative materials. The randomization of the restorative materials was done using a table of random numbers. The average age of the patients was 22 years (range: 20-32 years).

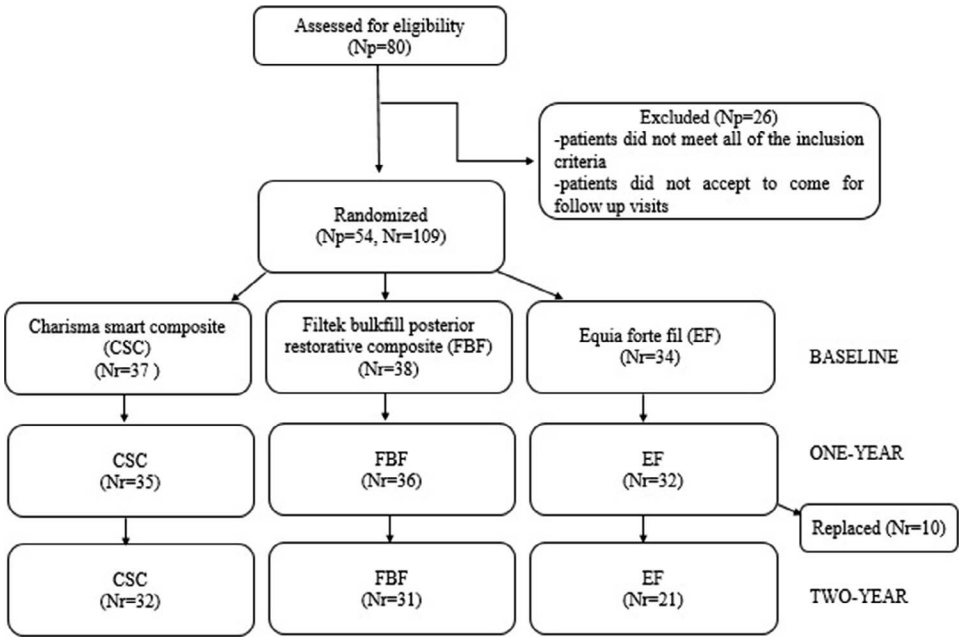

Figure 1. *Flow diagram. Np indicates number of patients; Nr, number of restorations.*

Initial bite-wing radiographs were taken before the treatment, and the most appropriate material color was selected before restorative procedures began. Local anesthesia was applied to patients who complained about pain or sensitivity to prevent discomfort during restorative procedures. Cavity preparations were performed using diamond fissure burs (Diamirsrl, Resia, Italy) at high speed with water cooling. Hand instruments and slow-speed tungsten carbide burs were used to remove caries. Conservative cavity design (Class II slot) was used, and beveling was not applied to the cavity walls to avoid the unnecessary loss of hard dental tissue. The outline shape of the cavity was limited to the removal of the caries lesion. Any additional retention was not prepared. The cavity preparations did not involve any cusps, all the gingival margins included sound enamel, and two surfaces cavities (MO or DO) were included in this study. $Ca(OH)_2$ cavity liner material (Dycal, Dentsply, Konstanz, Germany) was applied where needed as the base material (it was needed for only two restorations). Cotton pellets and suction were used to isolate the operative field. After an ivory-type matrix system (Ivory No. 1 matrix, Hahnenkratt, Königsbach-Stein, Germany) and wooden wedges were placed to the cavities, the cavities were disinfected with 0.2% chlorhexidine gluconate. All cavities were restored as follows.

Charisma Smart Composite Group—Single Bond Universal adhesive (3M ESPE, Neuss, Germany) was applied to the cavities according to the manufacturer's instructions and polymerized with a light-emitting diode light device (Valo, 1000 mW/cm^2, Ultradent, South Jordan, UT, USA) for 10 seconds. Charisma Smart Composite (CSC) was placed incrementally by using horizontal increments, not exceeding 2 mm in the cavity, and each layer was cured for 20 seconds. After removal of the matrix and wedges, the restorations were cured for an additional 10 seconds from the buccal and palatal/lingual sides.

Filtek Bulk Fill Posterior Restorative Group—Single Bond Universal adhesive was applied and polymerized as in group 1. Filtek Bulk Fill Posterior Restorative (FBF) was placed in bulk into the cavity, but at no more than 4 mm thick, and was cured for 20 seconds. After removal of the matrix and wedges, the restorations were cured for an additional 10 seconds from the buccal and palatal/lingual sides.

Equia Forte Fil Group—Cavity Conditioner (GC) was applied to the cavities for 10 seconds, washed, and gently dried. After isolation, an Equia Forte Fil (EF) capsule was placed in an automatic mixer and mixed for 10 seconds. The capsule was then placed in a special applicator and injected into the cavities. After the manufacturer's recommended setting time of 2.5 minutes, the restoration was finished, polished, and gently dried. Equia Forte Coat (GC) was applied to the restoration surfaces and cured for 20 seconds.

The finishing and polishing procedures were performed in the same appointment using high-speed fine diamonds (Meisinger Dental Burs, Hager & Meisinger GmbH, Neuss, Germany), Sof-Lex XT discs (3M ESPE), and yellow composite polishing rubbers (Nais, Sofia, Bulgaria).

Clinical Evaluation of the Restorations

In this study, all participating researchers were educated for calibration before the study was conducted. After the restoration placement, the patients were recalled after one week (baseline), six months, one year, and two years. The restorations were examined clinically using mirrors and probes, and bite-wing radiographs and intraoral photographs were taken from the patients. Dental floss was used to check the contact points. The restorations were evaluated by an experienced blinded investigator according to the modified USPHS criteria (Table 2). Intraobserver reliability was assessed using Cohen's Kappa, and it resulted in a Kappa value of 0.95.

Statistical Analysis

The data obtained were collected in a data pool, and statistical analyses were performed using the software program SPSS 22.0 (SPSS, Chicago, IL, USA). Frequency and rate values were used in the descriptive statistics of the data. For each parameter, chi-square and Fisher tests were used to compare the changes across different time points within each restorative material. In addition, the McNemar test was used to evaluate the difference between the materials. The level of significance was set at $\alpha=0.05$ for all tests.

RESULTS

A total of 109 restorations were placed in 54 patients. Fifty-one of these restorations (46.8%) were placed in premolars, and 58 (53.2%) were placed in molars. Eighty-four restorations were evaluated at the two-year recall with a 77% recall rate, while 103 restorations were evaluated at the one-year recall. None of the restorations showed any change up to six months. The number of evaluated restorations at baseline and at the one-year and two-year recall

Table 2: *Modified US Public Health Service Criteria Used in This Study*

Criteria	Alpha	Bravo	Charlie
Anatomic form	The restoration is continuous with the existing anatomic form	The continuity of restoration with teeth partially degraded but clinically acceptable	The continuity of restoration with teeth completely deteriorated, need to be replaced
Contact point	Normal contact point	No contact point but no periodontal irritation	No contact point, but there is a periodontal irritation finding/the patient wants to change the filling
Marginal adaptation	There is no visible evidence of a crevice along the margin into which the explorer will penetrate	There is visible evidence of a crevice along margin into which the explorer will penetrate or catch	The explorer penetrates the crevice, and dentin or base is exposed
Marginal discoloration	There is no discoloration anywhere on the margin between the restoration and the tooth structure	Discoloration is present but has not penetrated along the margin in a pulpal direction	Discoloration has penetrated along the margin in a pulpal direction
Secondary caries	No evidence of secondary caries	—	Evidence of secondary caries
Color match	The restoration matches the adjacent tooth structure in color and translucency	The mismatch in color and translucency is within the acceptable range	The mismatch in color and translucency is outside the acceptable range
Postoperative sensitivity	No postoperative sensitivity, after the restorative procedure and during the study	Slight sensitivity at any stage of the study	Severe sensitivity at any stage of the study
Retention	No loss of restorative material	—	Fracture and/or loss of restorative material
Surface texture	The surface of the restoration does not have any defects	The surface of the restoration has minimal defects	The surface of the restoration has severe defects

according to tooth type (premolar/molar) is given in Table 3. There was no significant difference between premolar and molar teeth for all parameters and all evaluation periods ($p>0.05$). The clinical evaluation scores of the restorations at baseline and at the one-year and two-year recalls are given in Table 4.

At the baseline evaluation, all CSC, FBF, and EF restorations were scored as "Alpha" for all criteria except color match. In the EF group, although the most appropriate material color was selected, eight restorations were scored as "Bravo" and 26 restorations scored as "Charlie" for the color match because of a lack of material translucency.

Color Match

At the one-year and two-year recalls, no significant color change occurred in the CSC and FBF groups ($p>0.05$). In the EF group, no color change was observed at the one-year evaluation when compared with baseline, while at the two-year recall, a slight improvement in color match of EF restorations was observed. Nevertheless, there was no statistically significant difference between the baseline, and the one-year and two-year color match of the EF group ($p>0.05$). There was a statistically significant difference between the EF group and the CSC and FBF groups for the color match ($p<0.05$), while there was no statistically significant difference between the CSC and FBF groups in any evaluation period ($p>0.05$).

Anatomic Form

Regarding the anatomic form criteria, there was a statistically significant difference between the EF

Table 3: *Distribution of the Materials According to Tooth Type at the Evaluation Periods*

	Baseline		One Year		Two Years	
	Premolar	Molar	Premolar	Molar	Premolar	Molar
Charisma Smart Composite	17	20	15	20	14	18
Filtek Bulkfill Posterior Restorative	18	20	16	20	14	17
Equia Forte Fil	16	18	15	17	12	9
Total	51	58	46	57	40	44

Table 4: *Baseline, One-Year, and Two-Year Clinical Evaluation of Restorations According to US Public Health Service Criteria*

Criterion	Baseline			One Year			Two Years		
	A	B	C	A	B	C	A	B	C
Anatomic form									
CSC	37	0	0	35	0	0	32	0	0
FBF	38	0	0	36	0	0	31	0	0
EF	34	0	0	26[a,b]	4	2	15[a,b]	5	1
Contact point									
CSC	37	0	0	35	0	0	32	0	0
FBF	38	0	0	36	0	0	31	0	0
EF	34	0	0	27[a]	0	5	14[a,b]	5	2
Marginal adaptation									
CSC	37	0	0	30	5	0	23[b]	9	0
FBF	38	0	0	34	2	0	27	4	0
EF	34	0	0	20[a,b]	10	2	10[a,b]	10	1
Marginal discoloration									
CSC	37	0	0	35	0	0	31	1	0
FBF	38	0	0	34	2	0	29	2	0
EF	34	0	0	31	1	0	20	0	1
Secondary caries									
CSC	37	—	0	35	—	0	32	—	0
FBF	38	—	0	36	—	0	31	—	0
EF	34	—	0	32	—	0	21	—	0
Color match									
CSC	37	0	0	35	0	0	32	0	0
FBF	38	0	0	35	1	0	31	0	0
EF	0[a]	8	26	0[a]	6	26	5[a]	10	6
Postoperative sensitivity									
CSC	37	0	0	35	0	0	32	0	0
FBF	38	0	0	36	0	0	31	0	0
EF	34	0	0	32	0	0	21	0	0
Retention									
CSC	37	—	0	35	—	0	32	—	0
FBF	38	—	0	36	—	0	31	—	0
EF	34	—	0	24[a,b]	—	8	15[a,b]	—	6
Surface texture									
CSC	37	0	0	35	0	0	30	2	0
FBF	38	0	0	36	0	0	31	0	0
EF	34	0	0	22[a,b]	9	1	11[a,b]	8	2

Abbreviations: A, Alpha; B, Bravo; C, Charlie; CSC, Charisma Smart Composite; EF, Equia Forte Fil; FBF, Filtek Bulkfill Posterior Restorative.
[a] *Significant difference between the restorative materials (*$p<0.05$*).*
[b] *Significant difference in comparison with baseline for each restorative material (*$p<0.05$*).*

group and the CSC and FBF groups ($p<0.05$), while there was no statistically significant difference between the CSC and FBF groups ($p>0.05$) at the one-year and two-year recall. However, no statistically significant difference was found between the one-year and the two-year clinical performances of the materials ($p>0.05$). For the EF group, the two-year results of the anatomic form showed a significant change compared with the baseline ($p<0.05$).

Contact Point

In terms of the contact point criteria, all of the restorations of the CSC and FBF groups scored as "Alpha," while 14 restorations were scored as "Alpha," five restorations were scored as "Bravo," and two restorations scored as "Charlie" because of marginal fracture or chipping in the EF group at the two-year evaluation. There was a statistically sig-

nificant difference between the EF group and the CSC and FBF groups ($p<0.05$), while there was no statistically significant difference between the CSC and FBF groups ($p>0.05$) at the one-year and two-year evaluation periods. Also, in the EF group, a statistically significant difference was found between the one-year and two-year evaluations ($p<0.05$). The two-year results regarding the contact point showed a significant change compared with the baseline only in the EF group ($p<0.05$).

Marginal Adaptation

In terms of the marginal adaptation criteria, there was a statistically significant difference between the EF group and the CSC and FBF groups ($p<0.05$), while there was no statistically significant difference between the CSC and FBF groups ($p>0.05$) at the one-year and two-year evaluations. However, at the two-year recall, a significant change was observed in the marginal adaptation of EF restorations when compared with the baseline and the one-year evaluation ($p<0.05$).

Marginal Discoloration

For marginal discoloration criteria, only two FBF restorations and one CSC restoration were scored as "Bravo," while one EF restoration was scored as "Charlie." In terms of the marginal discoloration criteria at the one-year and two-year evaluations, there was no statistically significant difference between the groups ($p>0.05$).

Secondary Caries and Postoperative Sensitivity

During the two-year evaluation period, no postoperative sensitivity or secondary caries were observed in any of the restored teeth, and all restorations were scored as "Alpha" for these criteria ($p>0.05$).

Retention and Survival Rate

In terms of the retention criteria, all evaluated CSC and FBF restorations were scored as "Alpha" in all the evaluation periods. In the EF group, eight restorations were scored as "Charlie" because of marginal fracture and material loss, which could be seen radiographically in the proximal area as a result of dissolution at the one-year recall. At the two-year recall, six additional EF restorations were scored as "Charlie" in terms of the retention criteria for the reasons mentioned above (Figures 2 and 3). However, a total loss of restorative material was not observed in any of the restorations during the two-year evaluation. In terms of the retention criteria, there was a statistically significant difference between the EF group and the CSC and FBF groups ($p<0.05$), while there was no statistically significant difference between the CSC and the FBF groups ($p>0.05$) at both the one-year and the two-year evaluation (Figures 4 and 5).

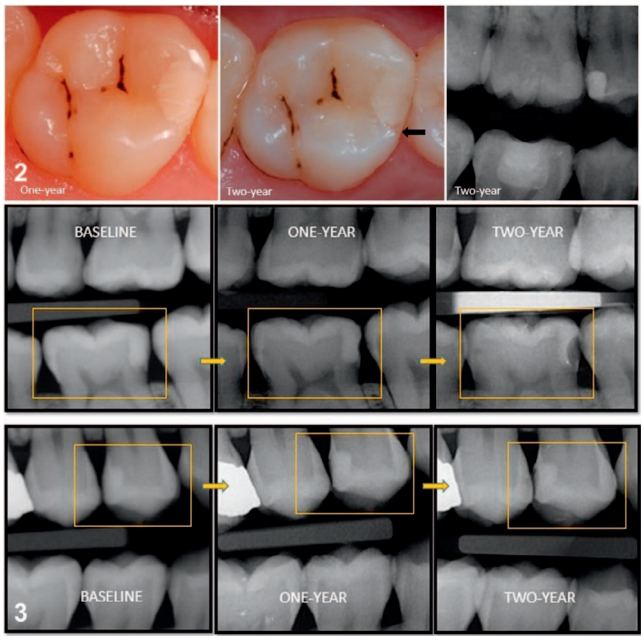

Figure 2. *One-year and two-year clinical appearance and two-year radiography of an Equia Forte Fil (EF) restoration. At the two-year evaluation, marginal fracture was observed.*

Figure 3. *One-year and two-year radiographies of Equia Forte Fil (EF) restorations. At the two-year evaluation, material loss in the proximal wall of the restorations was observed.*

After two years, the survival rates of the CSC and FBF groups were 100%, whereas the survival rate of the EF group was 54.3%. In total, 16 EF restorations (10 restorations at the one-year recall, six restorations at the two-year recall) had to be replaced or modified as a base due to marginal fracture and material loss in the proximal area during the two-year follow-up.

Surface Texture

During the two-year evaluation period, there was no significant change in the surface texture of the FBF and CSC restorations, unlike the EF restorations. In terms of the surface texture criteria, there was a statistically significant difference between the EF group and the CSC and FBF groups ($p<0.05$), while there was no statistically significant difference between the CSC and the FBF groups in the one-year and two-year evaluations ($p>0.05$).

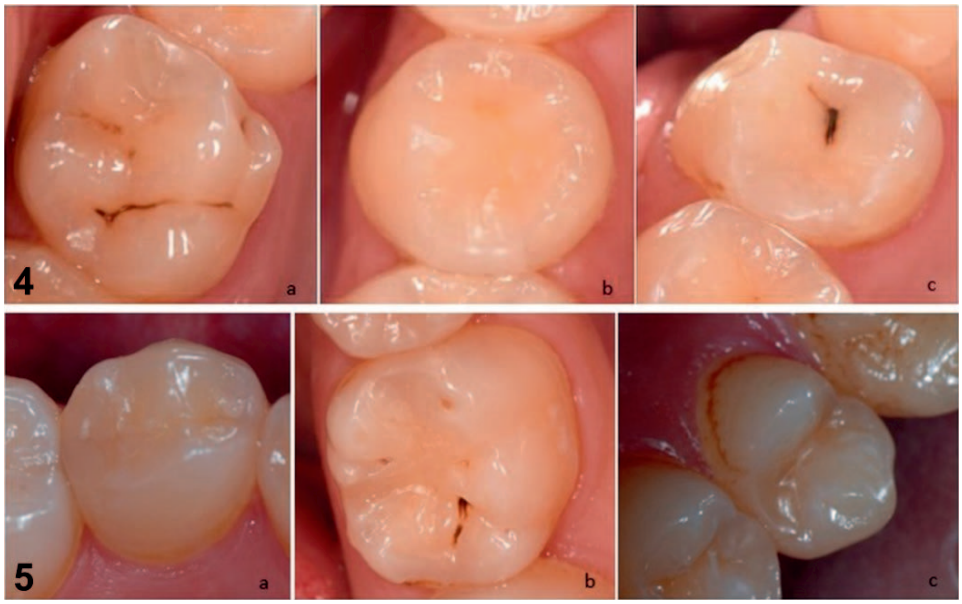

Figure 4. *Charisma Smart Composite (CSC) restorations scored as "Alpha" after the two-year recall.*

Figure 5. *Filtek Bulkfill Posterior Restorative (FBF) restorations scored as "Alpha" after the two-year recall.*

DISCUSSION

Bulk-fill restorative materials such as bulk-fill composite resins and HVGICs have recently become very popular materials in operative dentistry because they provide clinicians with an easy and quick application. The bulk application of restorative materials overcomes some challenges such as void formation and contamination risk between the layers and difficulty in the placement of layers in small cavities. In this clinical study, the clinical performances of three restorative systems were evaluated during a two-year period. The null hypothesis of this study was rejected because composite resin materials (conventional and bulk-fill) showed a significantly better clinical performance than HVGIC.

The retention rates represent the most important evaluation criteria to determine the clinical success of restorative materials. The American Dental Association requires a retention rate of at least 90% of the restorations after 18 months to obtain full acceptance.[17] In this study, the two-year survival rate of the CSC and the FBF restorations was 100%, while it was 54.3% for the EF restorations because 16 of 35 EF restorations required replacement at the end of two years. Based on this information, EF with low clinical success was considered unsuitable for the permanent restoration of Class II cavities, whereas bulk-fill and conventional composite resins were found to be clinically acceptable.

In the literature, no previous clinical study has attempted to compare the clinical performances of an HVGIC and a bulk-fill composite resin in Class II cavities. For this reason, it is not possible to make a direct comparison with previous studies. Çolak and others[18] and Bayraktar and others[19] evaluated the one-year clinical performances of Class II restorations made using either bulk-fill composite resin or conventional composite resin. The authors reported that the bulk-fill composite resins showed similar clinical performance when compared with conventional composite resin. The 12-month findings of the present study are consistent with their short-term data. Moreover, in another study comparing long-term clinical performances (10 years) of a hybrid composite resin and a bulk-fill composite resin in Class II cavities, the authors reported that both materials performed quite well clinically with no significant differences.[20] Although our evaluation period is two years, similarly, no difference was found between the clinical performances of bulk-fill composite and microhybrid composite. Yazıcı and others[21] evaluated the 36-month clinical performance of a nanofill composite resin and a bulk-fill composite resin in Class II restorations. According to their study results, at both 24 months and 36 months, the bulk-fill composite resin demonstrated better clinical performance in terms of marginal discoloration and marginal adaptation, while there was no difference between the materials in terms of other parameters. The data of the present study are not in agreement with the study of Yazıcı and others because no significant difference was found in terms of marginal discoloration or marginal adaptation of composite resin materials during the two-year period.

Gurgan and others[22] investigated the long-term clinical performance of the Equia restorative system on permanent posterior teeth in Class I and Class II caries lesions according to USPHS criteria and compared it with a microhybrid composite resin. The researchers reported that both restorative materials showed a clinically successful performance after 6 years. In another long-term clinical trial, the clinical performances of two different HVGICs (Equia Fil and Riva SC) were assessed using USPHS criteria.[23] The authors stated that Equia Fil showed acceptable clinical performance at the end of six years. However, Türkün and Kanik[23] did not assess the restoration as a fail since the restoration did not require a replacement, although it needed to be repaired. In our study, if the restoration needed to be repaired, it was evaluated as a fail. The restorations that had only a small degree of chipping that did not cause food impaction and did not require repair were maintained and monitored throughout the study.

In the literature, there are studies that evaluated the clinical and radiographic performances of Class II restorations involving HVGIC, and it was reported that concavity was seen radiographically on the proximal wall of the restorations at the 18-month recall.[24,25] In the present study, we also evaluated the clinical and radiographic performances of the restorations, and when any loss of restorative material (fracture and/or material loss in the proximal wall) was noted, these restorations were scored as "Charlie" in terms of the retention criteria. At the end of two years, the loss of material in the proximal wall that could be observed on radiographs was seen in a total of nine restorations (25.7%). We agree with previous studies on the cause of the occurrence of this material loss in the proximal wall of the restorations. It may be related to the inability of the protective resin to be applied effectively to the proximal wall of the glass ionomer restoration because it is not easy to access the proximal area. If the surface-coating agent cannot be applied effectively, the proximal area is unprotected from moisture contamination during the initial hardening phase, and the GIC may dissolve.[24,25] The use of metal matrices during the restorative procedure can also be another cause. GIC can adhere to metals chemically, and micro cracks may occur in GIC because of the force applied during the removal of the matrix. These micro cracks may make the material more susceptible to chemical attack.[25] Furthermore, it has also been reported that surface-coating agents wear over time.[24] In our study, deterioration in the surface texture was observed at the one-year and two-year evaluation of the EF restorations. We think that the wear of the surface-coating agent and the glass ionomer material may cause this deterioration.

In this study, the color match with the surrounding dental tissue of the restoration was a problem in the EF group. HVGICs have more translucency than conventional GICs. The HVGIC used in this study, also known as the glass hybrid system, has many color options. Even so, the color and translucency properties of HVGIC restorations were still not enough, and its color match was not as good as that of composite resin restorations up to one year. However, since the restorations were in the posterior region, and the patients were not disturbed by the appearance of the restorations, the replacing of the restoration was not considered in order to remedy the color mismatch. Also, it was known that the translucency of GICs would improve due to continuous maturation.[26] Our findings support this information. At the two-year evaluation, a slight improvement was observed in terms of the color match of the HVGIC restorations. We believe that this improvement in the color match is associated with increasing cement maturation. Consistent with our findings, Diem and others[27] reported that the color match of HVGIC restorations improved over the three years of the study (about 25% "good" at baseline, steadily increasing to about 80% "good" at three years) with improving translucency over time as the cement matures.

Secondary caries and postoperative sensitivity were not observed in any restoration during the two-year follow-up period. Chlorhexidine is commonly used as an antimicrobial agent for cavity disinfection, and it was used for cavity disinfection before the placing of the restorations in this study. Besides, EF is a fluoride-releasing restorative material, and it may have prevented the formation of caries under the restoration in this group. The absence of secondary caries could also be related to the good oral hygiene status of the patients. Cavity depth plays an important role in determining postoperative complications. The deeper the cavity, the greater the likelihood of postoperative sensitivity. In addition, operative trauma is another factor that may cause postoperative sensitivity.[28] In the present study, operative procedures (both cavity preparation and placement of the restoration) were done carefully by an experienced operator. The depth of cavities was mostly moderate in this study, and $Ca(OH)_2$ cavity liner material was applied in deeper cavities. In addition, a universal bond was used in the self-etch

mode in this study, and acid etching that removes the smear layer and requires technique sensitivity was not applied. All factors mentioned above might have had a favorable effect on postoperative sensitivity.

CONCLUSIONS

During a two-year follow-up period, a conventional microhybrid composite resin and a bulk-fill composite resin showed similar clinical performance, and these materials were found to be clinically more successful than a high-viscosity glass ionomer material. Moreover, within the limitations of this study, it can be concluded that the use of high-viscosity glass ionomer material as a permanent restorative material in Class II cavities is not appropriate.

Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of the Erciyes University, Faculty of Medicine Ethics Committee. The approval code issued for this study is 2017/44.

Conflict of Interest

The authors have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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