Original Article

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Clinical Evaluation of Class II Restorations Made with Bulk-fill Restorative Materials

Bulk-fill Restoratif Materyallerle Yapılmış Sınıf 2 Restorasyonların Klinik Değerlendirmesi

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ABSTRACT

Objective: The aim of this study was to evaluate the clinical performance of bulk-fill restorative materials applied to Class II cavities retrospectively.

Methods: In the study, Class II restorations which were restored with bulk-fill materials in the Department of Restorative Dentistry Selçuk University were determined from the records by using the HIMS (Hospital Information Management System) automation program and the patients were recalled for the controls. Three of the bulk-fill materials used in our clinic [Equia Forte (EF), Tetric EvoCeram Bulk-Fill (TBF) and Filtek Bulk-Fill Posterior Restorative (FBF)] were evaluated. A total of 79 patients and 192 restorations were included in the study. Restorations were assessed according to modified USPHS criteria during the 6th, 12th and 24th months from the date of application. The chi-square test was used for statistical analysis of the difference between the groups ($p<0.05$). The Cochran Q test was used for the significance of the difference between the time-dependent changes in each group ($p<0.05$).

Results: After 24 months, 139 restorations were evaluated in 64 patients. Thirteen EF and 3 TBF restorations were lost, while no loss was observed in the FBF group. There were clinically acceptable changes in composite restorations. In addition, no statistically significant difference was observed between the clinical performances of these materials in terms of all criteria ($p>0.05$). However, a statistically significant difference was observed between the only EF group and the TBF and FBF groups in terms of retention criteria at 24 months ($p<0.05$).

ÖZ

Amaç: Bu çalışmanın amacı Sınıf 2 kavitelere uygulanan bulk-fill restoratif materyallerin klinik performanslarını retrospektif olarak değerlendirmektir.

Yöntemler: Selçuk Üniversitesi, Diş Hekimliği Fakültesi, Restoratif Diş Tedavisi Anabilim Dalı'nda bulk-fill restoratif materyallerle restore edilen Sınıf 2 restorasyonlar HBYS (Hastane Bilgi Yönetim Sistemi) otomasyon programı kullanılarak kayıtlardan tespit edilip hastalar kontrollere çağrıldı. Kliniğimizde kullanılan bulk-fill restoratif materyallerden 3 tanesi olan Equia Forte (EF), Tetric EvoCeram Bulk Fill (TBF) ve Filtek Bulk Fill Posterior Restoratif (FBF) bu çalışmada karşılaştırıldı. Çalışmaya 79 hasta ve 192 adet restorasyon dahil edildi. Restorasyonlar yapılış tarihinden itibaren 6., 12. ve 24. aylarda modifiye USPHS kriterlerine göre değerlendirildi. Gruplar arasındaki farkın istatistiksel analizi için ki-kare testi ($p<0,05$) kullanıldı. Her grubun kendi içinde zamana bağlı değişimi arasındaki farkın anlamlılığı için Cochran Q testi ($p<0,05$) kullanıldı.

Bulgular: Yirmi dört ay sonunda 64 hastada 139 restorasyon değerlendirildi, EF grubunda 13 adet, TBF grubunda 3 adet restorasyon klinik olarak başarısız bulunurken; FBF grubunda klinik olarak başarısız restorasyon belirlenmedi. Kompozit restorasyonlarda klinik olarak kabul edilebilir değişiklikler gözlendi. Ayrıca kompozit materyaller arasında klinik performanslarının değerlendirildiği hiçbir kriterde istatistiksel olarak anlamlı fark bulunmadı ($p>0,05$). Yalnızca EF grubu ile TBF ve FBF grupları

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ABSTRACT

Conclusion: In this study, during a two-year follow-up period, the two bulk fill composite materials showed similar clinical performance; while the high viscosity glass ionomer material showed lower clinical performance.

Keywords: Bulk-fill restorative material, high viscosity glass ionomer cement, modified USPHS criteria

ÖZ

arasında 24. ayda retansiyon kriteri açısından istatistiksel olarak anlamlı farklılık gözlendi (p<0,05).

Sonuç: Bu çalışmada iki yıllık bir takip süresi boyunca, iki bulk fill kompozit materyal benzer klinik performans gösterirken; yüksek viskoziteli cam iyonomer materyal daha düşük klinik performans sergiledi.

Anahtar Sözcükler: Bulk-fill restoratif materyal, yüksek viskoziteli cam iyonomer siman, modifiye USPHS kriterleri

Introduction

Direct and indirect restorations are widely used for restoring posterior teeth in modern dentistry (1-4). Direct restorations are frequently preferred in the posterior region due to their low cost, preservation of healthy tooth tissue, shorter application time, and acceptable clinical performance (3). The use of materials that imitate tooth color is increasing with the development of adhesive systems along with increasing aesthetic concerns. However, an evaluation of long-term clinical follow-up is needed to determine the ideal materials to be used.

With the advancing technology, the aesthetic, mechanical and physical properties of composite resins are being improved. In addition, they are widely used in the posterior region, as they allow the cavity principle, which prevents excess material loss, by minimally invasive dentistry. However, polymerization shrinkage of these materials is still a problem to be solved (5,6). This shrinkage stress can cause negative results in the clinical success parameters of restorations (7,8). It has been tried to reduce the shrinkage stress with approaches such as increasing the amount of filler particles of composite resins or adding monomers with low shrinkage stress, applying different polymerization methods and placement techniques (7).

By applying the restorations in layers of 2 mm with the conventional technique, the polymerization depth is controlled and the polymerization shrinkage stress to occur is expected to decrease. However, in this technique, there is an air gap between the layers and risk of contamination. In addition, the difficulty of adaptation in narrow cavities and the long time to apply this technique can be a disadvantage for clinicians (8-11). It is expected to overcome these problems with the developed bulk-fill composite materials. Bulk-fill composites, which can be applied in layers of 4 mm, save both the patient's and the clinician's time. With the developments in resin-filling technology, the depth of polymerization has been improved by increasing the translucency of bulk-fill composites (12-15). In addition, polymerization shrinkage has been tried to be reduced by adding components such as stress-reducing monomers, higher molecular weight resins, and different polymerization modulators to these materials (16).

Conventional glass ionomer (CGIC) cements are used in the restoration of carious lesions in the posterior region where aesthetic expectations are not high. Advantages such as being chemically bonded to dental tissues, releasing fluoride, being biocompatible, and showing anti-cariogenic properties on the restoration edges increase their preference (17,18). Inadequate color stability, low wear and fracture resistance with low wear limit their use. They are not preferred especially in areas where chewing forces are intense (19).

High viscosity glass ionomer cement (HVGIC) has been produced by eliminating the negative properties of CGIC cement such as moisture sensitivity, low wear/fracture resistance, and insufficient color stability. These materials are also preferred in areas where chewing forces are high (19,20). The manufacturer recommends the use of this material with a surface covering resin. By applying the coating agent to the restoration surfaces, the gloss increases, and the loss of translucency that may occur over time decreases. In addition, irregularities and gaps that may occur after finishing and polishing processes are eliminated, resulting in smoother surfaces. Surface-sealing resins improve the mechanical properties of the restoration by reducing early moisture sensitivity and increasing wear/fracture resistance (21).

There are clinical follow-up studies of bulk-fill restorative materials, the use of which has increased recently, but; there are not many clinical studies comparing them with HVGIC. In this study, Class II restorations previously made in our clinic using bulk-fill restorative materials were evaluated at certain intervals using modified USPH criteria.

In this study, a 24 month clinical follow-up of Class II restorations restored with bulk fill restorative materials was performed. Our hypothesis is that Class II restorations made with bulk fill composites and HVGIC will show similar clinical success at the end of 24 months.

Methods

Study Design

This retrospective clinical study was approved by the Faculty of Dentistry Ethics Committee, Selçuk University, (approval no: 2017/14). In the study, Class II restorations restored with two bulk-fill composite resins (TBF, Ivoclar Vivadent, Liechtenstein, FBF Posterior Restorative, 3M ESPE, USA) and an HVGIC (Equia Forte Fil, GC, Tokyo, Japan) were evaluated. Restorations that were completed 6 months and made by the second author

(Bahar İnan) were selected. Clinical records were accessed from the HIMS (Hospital Information Management System) automation program.

Inclusion and Exclusion Criteria

For this retrospective clinical evaluation, the restorations meeting the following inclusion criteria were recruited: Patients who were; 1) older than 18 years old, 2) had good general health and oral hygiene, 3) had interface restorations of similar size in their premolars and molars and, 4) were able to attend control appointments were included. Inclusion criteria in the evaluated teeth; teeth were determined as 1) in contact with the opposing tooth, 2) exposed to normal occlusal forces on the dentition, 3) restoration width not exceeding ½ of the intercuspal distance and 4) normal responding to vitality tests without periodontal pathology.

1) Patients with poor oral hygiene, 2) those with active periodontal disease, 3) those with severe bruxism, 4) pregnant and lactating women and, 5) endodontically treated teeth were excluded from the study.

Finally; 79 patients (50 females, 29 males) and 192 restorations meeting the criteria between the ages of 18-53 were included in the study (Figure 1). The patients included in the study signed the informed consent form before the clinical evaluation.

Restorative Procedures

The contents, types and manufacturers of the restorative materials used in the study are listed in Table 1. All restorations were performed by the second author (Bahar İnan). The rutin restorative procedure for carious lesions that met the inclusion criteria of this study was as follows:

Cavity preparations were made with diamond burs under water cooling (Green band, NO:12C, SWS Dental, Turkey). The caries tissue was removed using tugten carbide burs at a slow-speed (Meisinger, Germany). Class II slot cavity design was used. No bevels were prepared. All the cavity margins were located in the sound enamel. $Ca(OH)_2$ based cavity lining material (Dycal, Dentsply, Konstanz, Germany) was applied where needed as the base material. The sectional matrix was placed in the cavities and fixed with wooden wedges. The isolation of the operative area was carried out with cotton pellets and suction. The application procedures of the materials used in restorations were as follows.

Equia Forte Fil (EF): EF capsule was mixed for 10 seconds with an automatic mixer (TAC 200/S, Linea Tac, Italy). Restorative material was placed into the cavity using the applicator. After the manufacturer's recommended setting time (2.5 minutes), the occlusion was checked and adjusted. Fine-grained diamond burs (Diatech, Colte`ne/Whaledent AG, Altsta¨tten, Switzerland) and Sof-Lex XT discs (3M ESPE, USA) were used for finishing and polishing. Then Equia Forte Coat was applied to the gently dried restoration surfaces and cured for 20 sec.

Bulk-Fill Composite Resins [Tetric Evo Ceram Bulk Fill (TBF)-Filtek Bulk Fill Posterior Restorative (FBF)]: The universal bonding agent (Adhese Universal, Ivoclar Vivadent, Liechtenstein) applied to air-dried tooth surface with rubbing action for 20 sec and then medium air pressure was applied to surface for 5 sec. Then restorations were photo-polymerized (Valo, 1,000 mW/cm^2, Ultradent, South Jordan, UT, USA) for 10 sec. Then a bulk-fill composite resin (TBF or FBF) was placed in bulk in about 4-mm thickness and then cured with the same curing unit for 20 sec. After the matrix and wedges

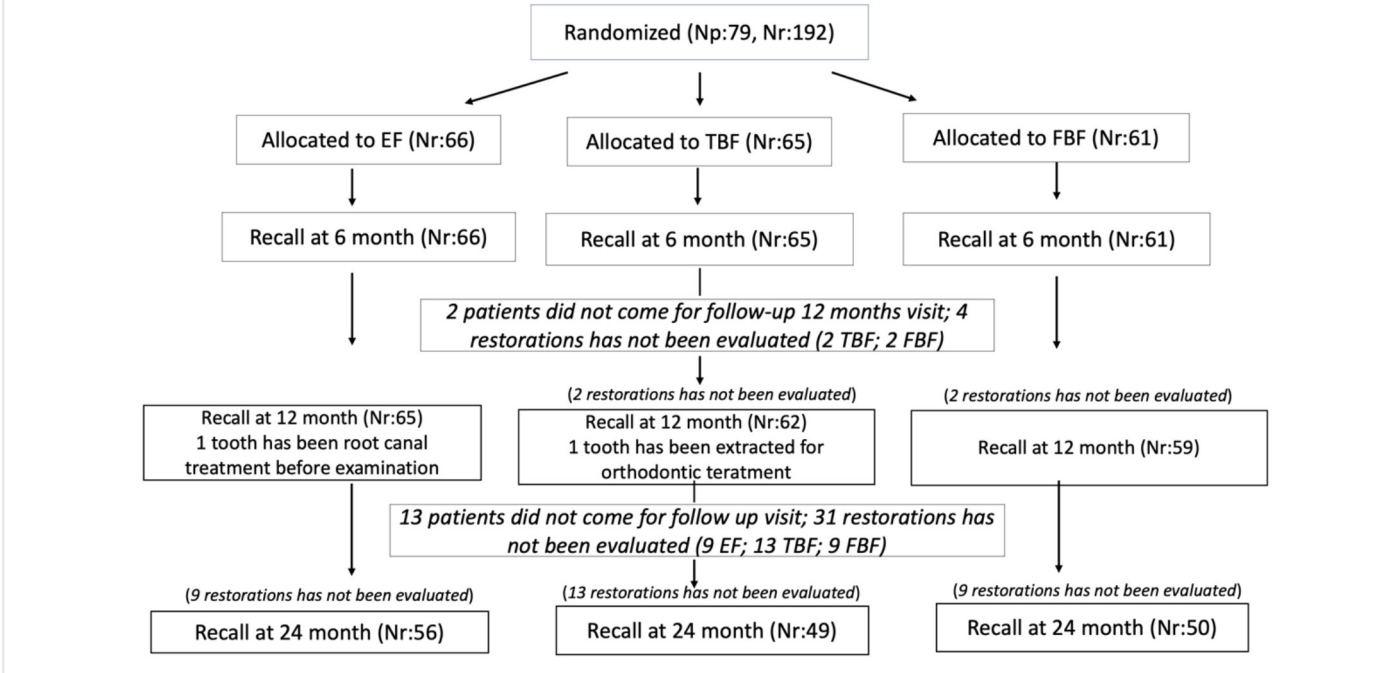

Figure 1. Flowchart of the trial

EF: Equia Forte, TBF: Tetric EvoCeram Bulk-Fill, FBF: Filtek Bulk-Fill

were removed, the restorations were re-cured for 10 sec from the buccal and palatal/lingual edges. The occlusion was checked and adjusted. Fine-grained diamond burs (Diatech, Colte`ne/Whaledent AG, Altsta¨tten, Switzerland), Sof-Lex XT discs (3M ESPE, USA) and rubber cups and points (Kerr, USA) were used for finishing and polishing.

Clinical Evaluation of the Restorations

The restorations were evaluated between January 2018 and February 2020 by two experienced investigators according to the modified USPHS criteria (Table 2) including several items on aesthetic, functional, and biological properties. The evaluation was done blinded. The patients were recalled , 12 and 24 months after the restoration placement. The restorations were evaluated in the dental unit under reflector light with mirror and probe. The radiographs taken for the diagnosis of caries or other reasons were evaluated in one- and two-year follow ups. Intraobserver reliability was assessed using Cohen's Kappa, and kappa values of 0.77 and 0.79 were found.

The cumulative retention rates of restorations over the years were calculated using the following equation (ADA Guidelines, 2001) (9,10): Cumulative failure = [(PF + NF)/(PF + RR)] x100. PF: previously lost restorations; NF: number of newly lost restorations seen during the session in which the patient was recalled and evaluated; RR: number of all restorations evaluated during the evaluated session.

Statistical Analysis

Statistical analysis was performed in SPSS statistical package program 22.0 (IBM Corporation, Armonk, NY, USA). The chi-square test ($p<0.05$) was used for statistical analysis of the difference between groups. The changes within each group

Table 1. Materials used in the study

Product name	Manufacturer	Composition
Adhese Universal	Ivoclar vivadent/ Liechtenstein	MDP, HEMA Bis-GMA, MCAP, D3MA, ethanol, water, silicon dioxit, camphorquinone, phosphoric acid components
Equia Forte Fil	GC/Tokyo, Japan	Powder: 95% strontium fluoro alumino-silicate glass, 5% polyacrylic acid liquid: 40% aqueous polyacrylic acid
Equia Forte Coat	GC/Tokyo, Japan	40-50% methyl methacrylate, 10-15% colloidal silica, 0.09% camphorquinone, 30-40% urethane methacrylate, 1-5% phosphoric ester monomer
Tetric EvoCeram Bulk Fill	Ivoclar Vivadent/Lichtenstein	Bis-GMA, UDMA, bis-EMA, barium alumina silicate glass filler, ytterbium fluoride, spherical mixed oxide
Filtek Bulk Fill Posterior Restorative	3M ESPE, St. Paul, MN, USA	Aromatic dimethacrylate (AUDMA), urethane dimethacrylate (UDMA), and 1,12-dodecane dimethacrylate (DDMA), zirconia/silica and ytterbium trifluoride filler

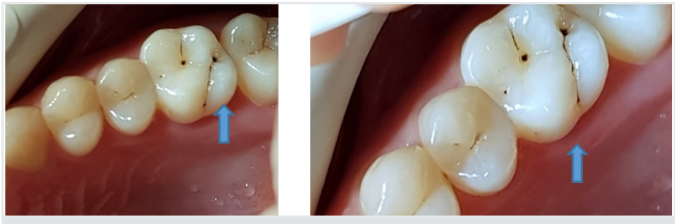

Figure 2, 3. Tetric EvoCeram Bulk Fill group with an ***Alpha*** score from all criteria, at 6- month and 12-month follow-ups (tooth number: 15)

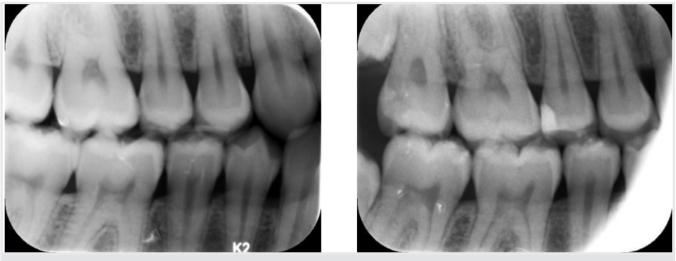

Figure 4, 5. Initial and 12-month bite-wing radiographs of the same restoration

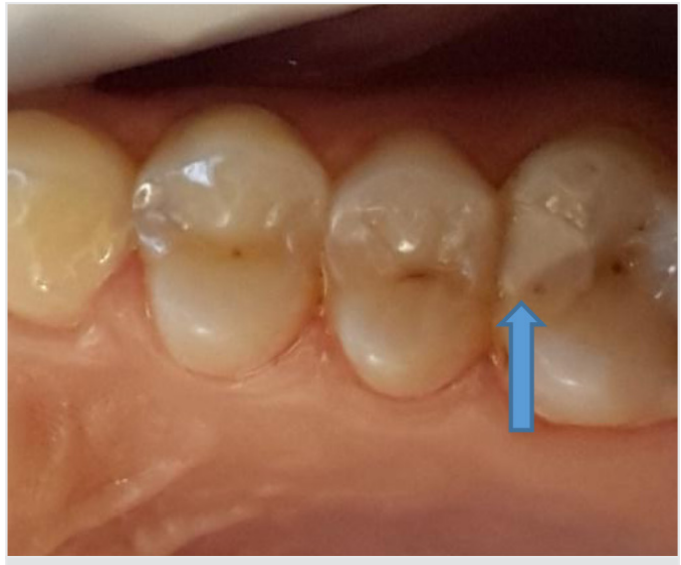

Figure 6. Restoration scored with ***Bravo*** for retention in the EF group at 12-month follow-up (tooth number: 16)

EF: Equia Forte

between different periods were analyzed by the Cochran Q test ($p<0.05$).

Results

A total of 192 restorations were evaluated in 79 patients in our study. Of the restorations, 105 (54.6%) were premolars and 87 (45.4%) were molars. (Table 3). Reassessment were performed at 6, 12 and 24 months. At the 6-month follow-up, all patients came to the control appointment. At the 12-month follow-up, 2 patients did not come and 4 restorations (2 TBF, 2 FBF) could not be evaluated. Additionally, before examination, it was observed that 1 tooth was extracted for orthodontic purposes and root canal treatment was applied to 1 tooth. These restorations were excluded from evaluation. One hundred-eighty-six restorations were evaluated in 77 patients. In the 24 month follow-up, 13 more patients did not come and 31 restorations (9 EF, 13 TBF and

Table 2. Modified US Public Health Service Criteria

Modified US Public Health Service Criteria Used in This Study		
Retantion	Alpha(A)	No loss of restorative material
	Bravo(B)	Partial loss of restorative material
	Charlie(C)	Complete loss of restorative material
Color match	Alpha(A)	The restoration matches the adjacent tooth structure in color and translucency
	Bravo(B)	The mismatch in color and translucency is within the acceptable range
	Charlie(C)	The mismatch in color and translucency is outside the acceptable range
Marginal discoloration	Alpha(A)	There is no discoloration anywhere on the margin between the restoration and the tooth structure
	Bravo(B)	Discoloration is present but has not penetrated along the margin in a pulpal direction
	Charlie(C)	Discoloration has penetrated along the margin in a pulpal direction
Marginal adaptation	Alpha(A)	There is no visible evidence of a crevice along the margin into which the explorer will penetrate
	Bravo(B)	There is visible evidence of a crevice along margin into which the explorer will penetrate or catch
	Charlie(C)	The explorer penetrates the crevice, and dentin or base is exposed
Secondary caries	Alpha(A)	No evidence of secondary caries
	Charlie(C)	Evidence of secondary caries
Surface texture	Alpha(A)	The surface of the restoration does not have any defects
	Bravo(B)	The surface of the restoration has minimal defects
	Charlie(C)	The surface of the restoration has severe defects
Anatomic form	Alpha(A)	The restoration is continuous with the existing anatomic form
	Bravo(B)	The continuity of restoration with the existing anatomic form teeth partially degraded but clinically acceptable
	Charlie(C)	The continuity of restoration with teeth completely deteriorated, need to be replaced
Postoperative sensitivity	Alpha(A)	No postoperative sensitivity, after the restorative procedure and during the study
	Bravo(B)	Slight sensitivity at any stage of the study
	Charlie(C)	Severe sensitivity at any stage of the study

Table 3. Distribution of tested materials according to tooth and arch

Experimental groups	Maxillar		Mandibular		Total
	Premolar	Molar	Premolar	Molar	
Equia Forte Fil	22	15	13	16	66
Tetric EvoCeram Bulk Fill	26	15	11	13	65
Filtek Bulk Fill Posterior Restorative	22	15	11	13	61
Total	70	45	35	42	192

9 FBF) could not be evaluated. During the evaluation, retention loss was observed for 13 EF and 3 TBF restorations, root canal treatment was performed on 2 teeth, 1 tooth was extracted, and 10 EF and 3 TBF restorations were renewed. One hundred-fifty-five restorations were evaluated in 64 patients. At the end of 24 months, the rate of patients coming to control was 81%.

The retention rate was 100% for EF, TBF and FBF restorations at six months. At 12-month control, 1 tooth in the EF group was scored with bravo while in the TBT and FBF groups, the retention rate was 100% (Figures 2-6). At the end of 24 months; 13 EF and 3 TBF restorations were lost.

In the EF group, all of the restorative material was lost in 5 restorations. Contact problems occurred due to material loss at the interface of 6 restorations. These restorations were renewed with Estelite Posterior (Tokuyama, Japan) composite resin. Root canal treatment was applied to 2 restorations.

In TBF group, two restorations had partial material loss in proximal area. These restorations were renewed. Root canal treatment was applied to 1 restoration.

No retention loss was observed in the FBF group. The clinical evaluation data of the restorations according to the USPHS criteria are shown in Table 4.

After 24 months, the cumulative retention loss of the EF group was 25%, whereas the cumulative retention loss of the TBF group was 6%. According to the retention data, the difference between the 6th, 12th, and 24th months evaluations in the EF group was statistically significant ($p<0.05$). At the end of 24 months, the retention data of the EF group were found to be significantly lower than the 6th and 12th months evaluations. Comparing restorative materials while the retention values of the EF group were found to be significantly more unsuccessful than the retention values of the TBF and FBF groups ($p<0.05$); there was no significant difference between TBF and FBF groups ($p>0.05$).

There was no statistically significant difference between the three groups for color match, marginal adaptation, marginal discoloration, secondary caries, anatomical form, surface texture, and postoperative sensitivity criteria ($p>0.05$).

Discussion

The use of bulk-fill restorative materials in posterior restorations is becoming widespread today. The ease of application of HVGIC and bulk-fill composite materials has increased their preference. In addition, some problems such as the formation of gaps between the layers, the risk of contamination and the difficulties in placing the layers in small spaces can be avoided with this placement method (22).

In vitro studies are carried out to examine the properties of the materials available to physicians firstly. However, since the results of these studies do not always reflect the truth, clinical studies are planned and the clinical performances of the materials are evaluated. In our research, Class II restorations made with three bulk-fill materials were followed periodically for 24 months. As a result of the study, it was observed that bulk-fill composite resin materials (TBF and FBF) showed more successful clinical results than high-viscosity glass ionomer cement (EF), and the null hypothesis of the study was rejected.

The retention parameter is very important in evaluating the clinical success of restorative materials. In the study presented by the ADA (23), it was reported that restorations should have a retention rate of at least 90% at the end of 18 months to be considered successful. In this study, the retention rate after 24 months was 76.7% in the EF, 93.8% in the FBF, and 100% in the TBF groups. Considering these data, it could be concluded that EF high viscosity-glass ionomer material applied as bulk fill material was not suitable for routine use in Class II restorations.

Although the use of high-viscosity glass ionomer cement has increased in clinical practice, clinical studies comparing these materials with different restorative materials are very few. There are clinical studies in the literature comparing bulk-fill composites with conventional composites (24-26). Balkaya and Arslan (22) followed Class II restorations made with EF, FBF, and Charisma Smart Composite conventional composite materials for 24 months. As a result of the study, it was observed that the retention values of the EF group (54.3%) were significantly lower, similar to our study. In addition, HVGIC restorative material showed significantly more unsuccessful results than composite materials in terms of the criteria of anatomical form, contact point, marginal adaptation, and surface properties. In another study performed in Class II cavities in primary molars, it was observed that HVGIC was significantly more unsuccessful in terms of retention criteria than a nanohybrid and two bulk-fill composites (27).

Gurgan et al. (28) examined HVGIC and micro-hybrid composite (Gradia Direct Posterior) in Class I and Class II cavities in a 4-year long-term clinical follow-up study. According to the results of the study, there was no significant difference between HVGIC and micro-hybrid composite in terms of

retention, anatomical form, secondary caries, surface structure, postoperative sensitivity and color match; differences were found in marginal adaptation and marginal discoloration (28). In the 6-year results of the same study, the clinical success of restorative materials was found to be similar (29). According to the results of the 2-year follow-up study of Friedl et al. (19); it was reported that the Equia system gave more clinically acceptable results in Class I and Class II cavities with less substance loss. Frankenberger et al. (30) reported that Equia was more successful in Class I restorations than Class II restorations. In these researches, Class I and Class II restorations were evaluated together. In addition, the last study reported that Equia was clinically better than Class II in Class I restorations. This might explain why HVGIC and composite materials showed similar retention values in these studies.

In another long-term clinical study, the clinical performances of two different high-viscosity glass ionomers (Equia Fil and Riva SC) applied to Class I and II cavities were evaluated using USPHS criteria (31). Class II restorations in the Equia Fil group were found to be more successful in terms of retention, marginal adaptation, and anatomical form parameters than in the Riva SC group. Restorations requiring repair were not evaluated as unsuccessful in this study. In our research, restorations requiring repair were deemed unsuccessful. This condition can explain inconsistent results.

In the literature, material losses in Class II restorations made with high-viscosity glass ionomers have been reported in the proximal regions (32,33). After the HVGIC is placed, the application of a surface coating agent is necessary for the initial curing phase of the material. The structural strength of the material may be adversely affected if the agent is not applied effectively. The material losses detected at the proximal surface may have been caused by the inadequate application of coating agents to these regions. In addition, these materials are subjected to wear due to chewing forces and environmental factors. Metal matrix bands are used in the made of proximal surface restorations in our clinic. Glass ionomers can form chemical bonds with metal matrix bands as they are placed in cavities, and the force generated during removal of the matrix bands can create microcracks in glass ionomers (33). In our study, proximal to occlusal or total losses were observed in restorations with a "Charlie" score in terms of retention. It can be thought that material losses could occur due to wear of the surface coating agent and deterioration of the structural strength of the glass ionomer cement.

Table 4. 6th, 12th and 24th months clinical evaluation of restorations according to US Public Health Service Criteria

		Equia Forte			Tetric EvoCeram Bulk Fill			Filtek Bulk Fill Posterior Restorative		
		6 months	One-year	Two-year	6 months	One-year	Two-year	6 months	One-year	Two-year
Retantion	A	66/66 (100%)	64/65 (98.5%)	56/43 (76.7%)	65/65 (100%)	62/62 (100%)	46/49 (93.8%)	61/61 (100%)	59/59 (100%)	50/50 (100%)
	B	-	1/65 (1.5%)	-	-	-	-	-	-	-
	C	-	-	56/13 (23.2%)	-	-	3/49 (7.2%)	-	-	-
Color match	A	66/66 (100%)	65/65 (100%)	37/43 (86.04%)	65/65 (100%)	62/62 (100%)	42/46 (91.3%)	61/61 (100%)	59/59 (100%)	45/50 (90%)
	B	-	-	6/43 (13.9%)	-	-	4/46 (8.7%)	-	-	5/50 (10%)
	C	-	-	-	-	-	-	-	-	-
Marjinal adaptation	A	66/66 (100%)	63/65 (96.9%)	40/43 (93.02%)	63/65 (96.9%)	60/62 (97.8%)	42/46 (91.3%)	61/61 (100%)	59/59 (100%)	46/50 (92%)
	B	-	1/65 (1.5%)	2/43 (4.6%)	2/65 (3.07%)	2/62 (3.2%)	2/46 (8.7%)	-	-	4/50 (8%)
	C	-	1/65 (1.5%)	1/43 (2.3%)	-	-	-	-	-	-
Marjinal discoloration	A	66/66 (100%)	65/65 (100%)	38/43 (88.3%)	65/65 (100%)	62/62 (100%)	42/46 (91.3%)	60/61 (98.4%)	58/59 (98.3%)	46/50 (92%)
	B	-	-	5/43 (11.6%)	-	-	3/46 (6.5%)	1/61 (1.6%)	1/59 (1.7%)	4/50 (8%)
	C	-	-	-	-	-	1/46 (2.1%)	-	-	-

Table 4. Continued

		Equia Forte			Tetric EvoCeram Bulk Fill			Filtek Bulk Fill Posterior Restorative		
		6 months	One-year	Two-year	6 months	One-year	Two-year	6 months	One-year	Two-year
Secondary caries	A	66/66 (100%)	65/65 (100%)	41/43 (95.3%)	65/65 (100%)	62/62 (100%)	46/46 (100%)	61/61 (100%)	59/59 (100%)	49/50 (98%)
	C	-	-	2/43 (4.6%)	-	-	-	-	-	1/50 (2%)
Surface texture	A	65/66 (98.5%)	64/65 (98.5%)	40/43 (93.02%)	65/65 (100%)	61/62 (98.4%)	44/46 (95.6%)	61/61 (100%)	59/59 (100%)	49/50 (98%)
	B	1/66 (1.5%)	1/65 (1.5%)	3/43 (6.9%)	-	1/62 (1.6%)	2/46 (4.4%)	-	-	1/50 (2%)
	C	-	-	-	-	-	-	-	-	-
Anatomic form	A	66/66 (100%)	63/65 (96.9%)	41/43 (95.3%)	65/65 (100%)	62/62 (100%)	46/46 (100%)	61/61 (100%)	59/59 (100%)	49/50 (98%)
	B	-	1/65 (1.5%)	1/43 (2.3%)	-	-	-	-	-	1/50 (2%)
	C	-	1/65 (1.5%)	1/43 (2.3%)	-	-	-	-	-	-
Postoperative sensitivity	A	64/66 (96.9%)	64/65 (98.5%)	41/43 (95.3%)	65/65 (100%)	62/62 (100%)	45/46 (97.8%)	60/61 (98.4%)	59/59 (100%)	50/50 (100%)
	B	1/66 (1.5%)	1/65 (1.5%)	1/43 (2.3%)	-	-	1/46 (2.2%)	1/61 (1.6%)	-	-
	C	1/66 (1.5%)	-	1/43 (2.3%)	-	-	-	-	-	-

A: Alpha, B: Bravo, C: Charlie

Although HVGIC's translucency is higher than conventional glass ionomers, color matching is still improving. According to the results of the study, the color match and marginal discoloration values of all materials were found to be similar. Even if the oral hygiene status was considered in the inclusion criteria of the patients, the differences in the amount of consumption of coloring foods and drinks might be effective in finding similar results. In addition, as the maturation time of glass ionomers increases, the translucency ratio also increases (34). There are also studies showing that color match improves over time (35).

The surface structure and anatomical form of restorations may be relevant to specific characteristics such as the patient's habits, diet, or the type and content of materials. All the materials we used in our study showed clinically successful results at the end of 24 months in terms of surface structure and anatomical form parameters. Composite resins have been found successful in many long-term clinical follow-up studies. The similar results of the glass ionomer restorations in our study may indicate that their mechanical properties have been improved compared to conventional glass ionomers.

There was no significant difference between the restorative materials at the end of 24 months in terms of postoperative sensitivity and secondary caries data. The fact that the patients had good oral hygiene habits, and the fluoride release feature of EF might be effective in the absence of secondary caries. Postoperative sensitivity is closely related to the depth of the cavity and traumatic cavity preparation (36). In the restoration procedure, calcium hydroxide based cavity lining material was placed close to the pulp in very deep cavities. The restorations in the study were made with adhesive system applied in self-etch mode. No acid application might have a significant effect on the absence of postoperative sensitivity.

Study Limitations

This research study was conducted retrospectively. Although specific criteria were observed when including patients in the study, it was not possible to standardize as much as prospective studies. In addition, since the 24-month follow-up coincided with the COVID-19 pandemic, the rate of patients coming to control appointments decreased.

Conclusion

At the end of 24 months, bulk fill composite materials showed successful results in all clinical parameters. HVGIC material was clinically unsuccessful only in terms of the retention criteria. These results indicate that the use of HVGICs in Class II restorations should be limited.

Ethics

Ethics Committee Approval: This retrospective clinical study was approved by the Faculty of Dentistry Ethics Committee, Selçuk University, (approval no: 2017/14).

Informed Consent: Obtained.

Peer-review: Externally peer reviewed.

Authorship Contributions

Surgical and Medical Practices: M.G., B.İ., N.Ç., Concept: M.G., B.İ., N.Ç., Design: M.G., B.İ., N.Ç., Data Collection or Processing: M.G., B.İ., N.Ç., Analysis or Interpretation: M.G., B.İ., N.Ç., Literature Search: M.G., B.İ., N.Ç., Writing: M.G., B.İ., N.Ç.

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