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Original research

ONE-YEAR CLINICAL EVALUATION OF CLASS II INDIRECT PORCELAIN, HYBRID AND COMPOSITE BLOCKS RESTORATIONS

ABSTRACT

Objectives: This clinical study aims to evaluate the clinical performance of indirect class II restorations made using three different CAD/CAM blocks.

Materials and Methods: A total of 60 indirect class II restorations were performed in 41 patients using Cerasmart (GC Dental Products Europe, Leuven, Belgium) composite, IPS e.max CAD (Ivoclar Vivadent, Schaan, Liechtenstein) ceramic and Vita Enamic (Vita Zahnfabrik, Bad Sackingen, Germany) hybrid blocks. The restorations were evaluated for 13 different criteria using modified FDI criteria at the end of one week, six months, and one year. Data were analyzed using the Chi-square, Fischer and Mc Nemar tests.

Results: Vita Enamic indirect restorations showed a statistically significant difference in terms of color matching criteria from Cerasmart and IPS e.max CAD using groups in all follow-up periods (p<0.05). There was no significant difference between the groups in terms of other criteria (p>0.05).

Conclusion: Cerasmart and IPS e.max CAD restorations showed better color matching than Vita Enamic restorations.

Keywords: CAD/CAM, ceramic block, hybrid block, indirect restoration.

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INTRODUCTION

The demand for posterior aesthetic restorations as an alternative to amalgam has been increasing for the last 25 years.[1] Today, numerous different techniques are used in the construction of posterior restorations[2], and the most commonly used techniques are direct composite restorations. However, when direct composite restorations are used in the posterior region; abrasion, fracture, polymerization shrinkage due to the deterioration of the edge compatibility, followed by microleakage, secondary caries and postoperative sensitivity are disadvantages.[3] In order to prevent these problems, inlay/onlay techniques have been developed by using metal, composite or ceramic materials.[2]

If a cavity is large enough to be contraindicated in direct restorative techniques and an aesthetic restoration is considered; composite, ceramic, and hybrid indirect restorations are indicated. Since these restorations are prepared outside the mouth, the polymerization shrinkage is no longer a problem. Occlusal anatomy and proximal contact can be established more successfully. Besides, they have better physical properties than direct composite restorations because they are prepared under more ideal conditions.[1]

The restoration of modern materials with traditional production techniques has not shown sufficient clinical success, leading to the development of new production techniques. The most modern system used today is the CAD/CAM system (computer-aided design/computer-aided manufacturing).[4] The CAD/CAM system used in the clinic provide clinicans with a choice of different restorative materials to suit their cases.[5] Industrially manufactured standard-manufactured scrapable CAD/CAM blocks can be composite, ceramic, or a hybrid structure that includes some properties of both materials.[6]

Different methods such as the FDI evaluation system, the CDA evaluation system, and the USPHS evaluation system can be used for clinical evaluation of indirect restorations.[7] The USPHS criteria have three rating scores, while the FDI has five scores, which makes FDI assessments more sensitive.[8] FDI criteria were approved by the scientific committee of the FDI World Dental Federation in 2007 as criteria and classification, and in 2008 they were accepted as the standard criteria for the evaluation of restorative materials or operative techniques as clinical research. The use of FDI criteria in clinical cases can be modified in terms of criteria and scoring, thus FDI criteria offer different options to researchers.[9]

In the literature, there are in-vitro studies investigating the physical and mechanical properties of CAD/CAM blocks of different structures, while studies evaluating the clinical performance of these materials are not sufficient. Therefore, in the present study, we aim to evaluate the one-year clinical performance of indirect class II restorations made of Cerasmart composite block, IPS e.max CAD ceramic block and Vita Enamic hybrid blocks and by using modified FDI criteria. The null hypothesis of this study is that there would be no significant differences in the clinical performance among the indirect restorations made with these three different blocks.

MATERIALS AND METHODS

Study Design

The study was approved by the Erciyes University Clinical Research Ethics Committee, Turkey (Decision No: 2017/452). The study design was a controlled randomized clinical trial and was registered at www.clinicaltrials.in.th (TCTR identification No. TCTR20191212002), and this study follows CONSORT guidelines. The registration of the records of all patients (n=41) who had received indirect restorations (n=60) from a total of 800 patients were made during the period in February 2018 to August 2018. Patients selected from ordinary patients who were referred to the dental clinic of the Department of Restorative Dentistry, Erciyes University, and were treated by a dentist with experience of restorative dentistry. The randomization of restorative materials was done using a table of random numbers.[10] The indication for treatment was the replacement of failed restorations or primary caries class II preparations on premolar and molar teeth. A list of the inclusion and exclusion criteria adopted in the study is provided in (Table 1).

Table 1. List of inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Vital teeth	Non-vital teeth
Absence of clinical signs and symptoms of periapical pathology	Patients with parafunctional habits
The presence of teeth in the proximal contact of the restoration	Teeth with cusp loss
Teeth being in occlusion to antagonistic teeth	Teeth subjected to direct pulp-capping
Patients who agreed to attend regular checks	Severe periodontal problems

All patients were males and females at least 18 years of age with regular oral hygiene. The flowchart for patient selection and treatment protocol is given in Figure 1.

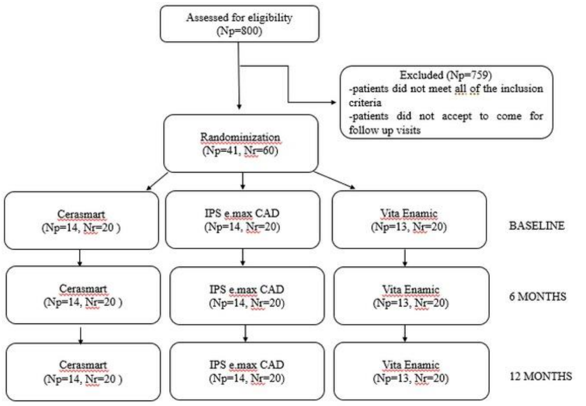

Figure 1. Study Flowchart, Np: number of patients, Nr: number of restorations

Patients were informed about the need for good gingival health and were educated in effective plaque control. Both preoperative and post-operative photographs were taken for each patient in order to evaluate changes in appearance (Fig. 2-4). Gingival bleeding indexes of all patients were evaluated.[11]

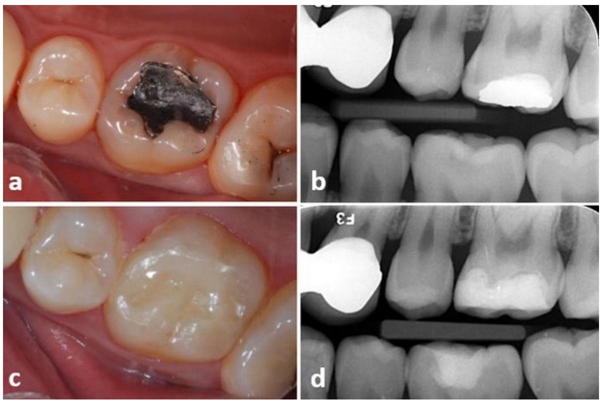

Fig. 2 (a) A maxillary left first molar, with caries recurrence on an occlusal amalgam restoration **(b)** Bite-wing radiograph of the maxillary left first molar **(c)** 1 year follow-up of cerasmart indirect restoration **(d)** Bite-wing radiography of cerasmart indirect restoration

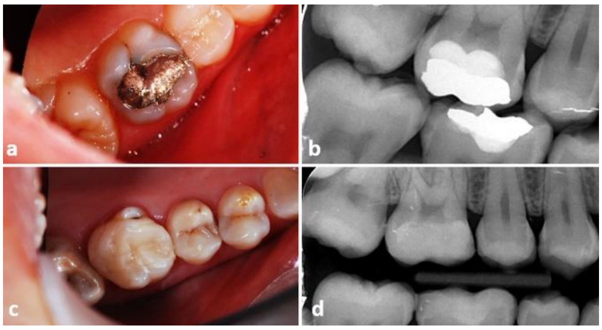

Fig. 3 (a) A maxillary right first molar, with caries recurrence on an occlusal amalgam restoration **(b)** Bite-wing radiograph of the maxillary right first molar **(c)** 1 year follow-up of IPS e.max indirect restoration **(d)** Bite-wing radiography of IPS e.max indirect restoration

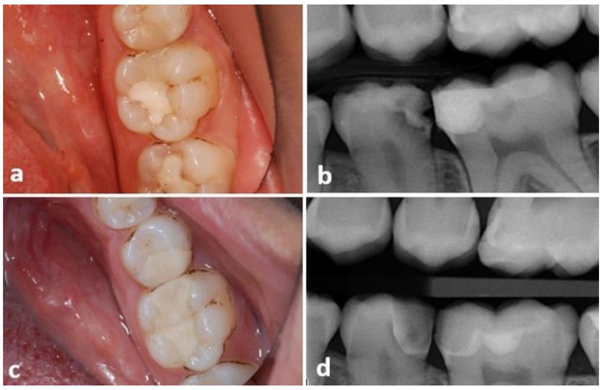

Fig. 4 (a) A mandibular left second premolar and first molar, with caries recurrence on an occlusal composite restoration **(b)** Bite-wing radiograph of the mandibular left second premolar and first molar **(c)** 1 year follow-up of Vita Enamic indirect restoration **(d)** Bite-wing radiography of Vita Enamic indirect restoration

Tooth Preparation

Materials, manufacturers, chemical compositions, and batch numbers of main materials used in this study are listed in Table 2. Since the restoration of vital teeth was planned, treatment was started with the removal of the old restorative material and/or the caries under local anesthesia.

Table 2. Restorative materials used in study

Material	Manufacturer	Compositions	Batch number
IPS e.max CAD	Ivoclar Vivadent (Schaan, Liechtenstein)	SiO_2 (57-80%), Li_2O (11-19%), K_2O (0- 13%), P_2O_5 (0.5-11%), ZrO_2 (0-8%), ZnO (0- 8%), Al_2O_3 (0-5%), MgO (0-5%), oxide pigments (0-6%)	W36995
Cerasmart	GC (Leuven, Belgium)	Bis-MEPP, UDMA, DMA, weight %71 silika (20 nm), baryum cam (300 nm) nano partikülleri	1411041
Vita Enamic	Vita-Zahnfabrik (Bad Sackingen, Germany)	Ceramic: SiO_2 (58-63%), Al_2O_3 (20-23%), Na_2O (6-11%), K_2O (4-6%), B_2O_3 (0.5-2%), CaO (<1%), ZrO2 (<1%), Polymer: UDMA, TEGDMA	61280
Silan	Ultradent (Cologne, Germany)	Etanol, 3-trimetoksipropil metakrilat,10-MDP (MDP), sülfid metakrilat	BG3TD
RelyX U200	3M ESPE (St. Paul, MN, USA)	Base paste: fiberglass, phosphoric acid methacrylate esters, TEGDMA, silano treated sílica and sodium persulfate.	3324998
Telio CS Onlay	Ivoclar Vivadent (Schaan, Liechtenstein)	The monomer matrix consists of methacrylates (by weight) 36.3%). Dispersed silicon dioxide and copolymers (62% by weight. Fluoride (1500) ppm), catalysts, stabilizers and pigments (0.6% by weight)	W98823

All walls of the cavity were prepared using onlay bur (Frank Dental GmbH, Gmund, Germany) at an angle of 6-10º with the long axis of the tooth. Internal angles were smoothed to reduce the stress concentration, and contacts at the marginal ridge were avoided. The preparation of margins were not bevelled but prepared as butt joint form. A light-curing composite filling material (i-FLOW; i-dental, Siauliai, Lithuania) was then used to block out defectrelated undercuts and to maintain a standardized preparation protocol.

After the preparation of the retraction cord (AtriaPak, Seoul, South Korea) was placed in the gingival sulcus to remove the gum from the cavity. Impressions were made using a silicone impression material (Heavy and Light Body Zetaplus, Zhermack, Bovazeccihino, Italy) using an individually designed impression tray. Temporary restorations were then made chairside using a photopolymerized resin composite material (Telio CS Onlay, IvoclarVivadent, Schaan, Liechtenstein).

Laboratory Operations

After the measurements were sent to the laboratory, the Dentalwings (DWOS, Montreal, Canada) the device was scanned. The scanned measurements were transferred to a computer, and restorations were designed in exoCAD program. Designed restorations were transferred to Dentaswiss DS1300 (Biodenta Swiss, Berneck, Switzerland) and milled from the blocks placed in the device. One dental technician fabricated all indirect restorations.

Indirect ceramic restorations were obtained by milling only IPS e.max CAD blocks in the CAD/CAM device are present in the blue/purple precrystallized phase at this stage while being crystallized for 10 minutes at 850 ° C in the Programat EP 5010 (Ivoclar Vivadent, Schaan, Liechtenstein), the furnace in the laboratory. Finally, a glaze layer was applied.

Placements of the Indirect Restorations

Before permanent restorations were placed in teeth, the temporary filling material was removed from the tooth and the cavity was cleaned with alcohol. Each type of material was treated in accordance with the manufacturers' instructions before the cementation. The internal surfaces IPS e.max CAD and Vita Enamic restorations were etched with 9.5% hydrofluoric acid (Porcelain Etch, Ultradent, South Jordan, UT, USA) and Cerasmart restorations were abraded with 50 µm aluminium oxide (KaVo, Biberach, Germany), using an intraoral sandblasting device (KaVo RONDOflex plus 360, Biberach, Germany). The tip of the micro etcher was kept 5 cm away from the surfaces and applied for 10 s at 2.0 bar pressure.[12] Restorations were subsequently rinsed under running water to remove the debris (20 s), cleaned in an ultrasonic device (2 mins), and air-dried.

All restorations were treated with a silane coupling agent (Ultradent, South Jordan, UT, USA) for 60 seconds and air-dried. Each tooth was isolated with a cotton roll and saliva suction device, there was no need to use a rubber dam. Also, the cavity was isolated with the help of the sectional matrix (Standard matrix, Palodent, Dentsply, York, PA, USA) and wedge. Then, phosphoric acid was applied to enamel surfaces for 30 seconds washed, and dried.

All indirect restorations were cemented by a self-adhesive resin cement (RelyX U200, 3M ESPE, St. Paul, MN, USA). The light-curing operation was made (VALO, Ultradent, South Jordan, UT, USA) for 40 seconds from each aspect of the restoration.

Centric and eccentric occlusal contacts were adjusted with diamond finishing burs before Soflex spiral disks (3M ESPE; St Paul, MN, USA). Overhangs were removed and polished in the same way, proximally with interdental polishing strips (GC Epitex strips, Leuven, Belgium).

Evaluation of Restorations

Indirect restorations were evaluated by an experienced dentist after one week, six months and one year. Bite-wing radiographs and photographs were taken from restored teeth in each control session. Modified FDI criteria were used to evaluate restorations.[9] There were three evaluation categories (aesthetics, function and biological). A blinded and calibrated experienced dentist performed follow-up evaluation.

Statistical Analysis

The distribution of variables was measured by the Kolmogorov Smirnov test. The Chi-Square test was used for the analysis of independent qualitative data and the Fischer test was used when the Chi-Square test conditions were not met. The McNemar test was used to evaluate the secondary qualitative data. The SPSS 22.0 program was used in the analyses.

RESULTS

A total of 41 patients (27 females, 14 males) aged 18-47 years (mean 29,27 ± 9,14) participated in the study. In 41 patients, 21 premolars (mandible 9, maksilla 12), 39 molar (mandible 22, maksilla 17) indirect restorations were applied to a total of 60 teeth. When the gingival index was evaluated, eight patients had bleeding and 33 patients had no bleeding. All patients were evaluated at one week, six months and one year.

At the end of one year, clinical failure was seen in one restoration due to the periodontal response in the Vita Enamic group. The success rate of Cerasmart and IPS e.max CAD indirect restorations after 12 months was 100%, while that of Vita Enamic restorations was 95%. The results for baseline and follow-up evaluation are summarized in Table 3.

Table 3. Results of the clinical evaluation at baseline and after 6 and 1 year

		Cerasmart			IPS e.max CAD			Vita Enamic		
		Baseline 1/2/3/4/5	6 months 1/2/3/4/5	1 year 1/2/3/4/5	Baseline 1/2/3/4/5	6 months 1/2/3/4/5	1 year 1/2/3/4/5	Baseline 1/2/3/4/5	6 months 1/2/3/4/5	1 year 1/2/3/4/5
Esthetic	Surface gloss	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0
	Surface/marginal staining	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0
	Color match	20/0/0/0/0a	20/0/0/0/0x	20/0/0/0/0α	20/0/0/0/0a	20/0/0/0/0x	19/1/0/0/0α	6/14/0/0/0^{b}	6/14/0/0/0^{y}	8/12/0/0/0^{β}
	Anatomic form	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0
Functional	Fractures and retention loss	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	19/1/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0
	Marginal adaption	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	17/1/2/0/0	20/0/0/0/0	20/0/0/0/0	19/1/0/0/0
	Wear	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0
	Contact point	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0
Biological	Patient satisfaction	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0
	Postoperative hypersensitivity	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	19/1/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0
	Caries/erosion/	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0
	abfraction				20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0
	Tooth integrity	20/0/0/0/0	20/0/0/0/0	20/0/0/0/0						
	Periodontal response	20/0/0/0/0	19/0/1/0/0	18/0/1/1/0	20/0/0/0/0	20/0/0/0/0	18/0/2/0/0	20/0/0/0/0	20/0/0/0/0	17/1/2/0/0

a, b : Evaluation of baseline comparisons of Cerasmart, IPS e.max CAD and Vita Enamic restorations
x, y : Evaluation of 6 months comparisons of Cerasmart, IPS e.max CAD and Vita Enamic restorations
α, β : Evaluation of 12 months comparisons of Cerasmart, IPS e.max CAD and Vita Enamic restorations

Esthetic Characteristics

There were no changes for the surface gloss, surface/marginal staining, and anatomic form criteria at the follow-up evaluation, compared to the baseline evaluation ($p>0.05$). In the IPS e.max CAD group, one restoration had reduction for criteria color match from clinically excellent (category 1) to clinically good (category 2) at 12-month evaluation. In the Vita Enamic group, 14 indirect restorations after one week and six months and 12 indirect restorations after one year were evaluated as clinically good (category 2). The Vita Enamic group was significantly different from other groups in all follow-up periods ($p<0.05$).

Functional Characteristics

There was no change for marginal adaptation, wear and contact point criteria at the follow-up evaluation, compared to the baseline evaluation ($p>0.05$). In the IPS e.max CAD group, one restoration showed fracture and retention loss and evaluated as clinically good (category 2) in the follow-up evaluation.

Biological Characteristics

At the follow-up evaluation, 100% of the patients were satisfied with their restorations (category 1). At twelve months follow-up evaluation revealed a small amount of post-op hypersensitivity for a short time (category 2) in one restoration in the IPS e.max CAD group. There was no recurrence of initial pathologies, like caries, erosion, or abrasion at the follow-up evaluation (category 1). There was no change for tooth integrity criteria at follow-up evaluation, compared to the baseline evaluation. At one year evaluation, one restoration in the Cerasmart group was scored as '4', one restoration as '3', two restorations in the IPS e.max CAD group were '3' and two restorations in the Vita Enamic group were '3'. Since the score '4' required treatment, the patient was referred to the periodontology clinic ($p>0.05$).

DISCUSSION

In this study, one-year clinical performances of indirect restorations to posterior vital teeth using three different CAD/CAM blocks (Cerasmart, IPS e.max CAD, Vita Enamic) with different contents were evaluated, and no statistically significant difference was found except for color matching. Therefore, our initial hypothesis was partially accepted.

Nowadays, increasing demands for aesthetic restorations, many discussions on possible side effects of dental amalgam, and problems (polymerization shrinkage, microleakage and secondary caries) with the use of composite resins for extensive restorations in posterior teeth have led to an increased interest in indirect posterior teeth restoration.[13] Özakar-İlday *et al.*[14] performed three year follow-up study of 60 direct and indirect composite restorations and found that indirect restorations showed better clinical results than direct restorations. As seen in clinical studies, indirect restorations in the posterior region showed higher success than direct restorations. Therefore, in our study, we preferred to perform indirect restorations to posterior teeth with class II cavities that require restoration.

Indirect restorations can be produced in different ways. Conventional indirect restorations include many procedures such as measuring, occlusal recording, preparing a working model from plaster, shaping wax or restorative materials, waxing, and firing. Besides, dental CAD/CAM systems for indirect restorations have shown rapid progress and now are used worldwide.[15] CAD/CAM systems are advantageous in that restorations, for instance they can be performed in a single session.[16] Hickel and Manhart[17] reviewed annual failure rates of posterior restorations in the dental literature and reported this rate as 0-11.8% for conventional composite indirect restorations, 0-4.4% for CAD/CAM indirect restorations.

The increase in the aesthetic expectations of patients have led to the development of full ceramic restorations as well as the development of other metal-free dental materials with different mechanical and optical properties used with CAD/CAM. Ceramic and hybrid blocks are used in CAD/CAM systems. In recent years, manufacturers have introduced the CAD/CAM material group called “hybrid ceramics” with the claim that they reflect the positive properties of ceramic and composite materials. In various studies, it is emphasized that these materials having ceramic and polymer double web structures can be processed more efficiently, are less brittle, and provide better edge compatibility.[18] Nowadays, hybrid nano ceramic and resin infiltrated ceramic materials are available on the market.[19] Della Bona *et al.*[20] reported that Vita Enamic's(a polymer infiltrated ceramic structure material) mechanical properties, which has been used in the study, were average of ceramic and composite materials. Awada *et al.*[21] compared Vita Enamic, Lava Ultimate, Cerasmart, IPS Empress CAD, Vita Block Mark II, and Paradigm MZ100 CAD/CAM blocks' mechanical properties (bending modulus, bending strength, and flexibility modulus) and the edge compatibility. In general, they stated that polymer-based materials outperform ceramic materials in bending tests. In the study, it was stated that the difference observed between the materials in terms of elastic properties was the resin component and the resin component was found to help reduce the brittleness of the material. For these reasons mentioned above, we preferred to use ceramic and hybrid blocks to compare the clinical behavior of different CAD/CAM blocks in our study.

In the present study, self-adhesive resin cement RelyX U200 was used in cementation of 60 indirect restorations and no cement-induced failure was observed. Similar to our study, Azevedo *et al.*[22] 42 adhered indirect restorations with self-adhesive cement for one year and reported that there was no failure at the end of one year. In contrast in a study by Kim *et al.*[23], two self-adhesive cement compared with traditional resin cement and traditional resin cement has shown higher bond strength than self-adhesive resin cements. The reason for this difference may appear due to the application of acid to enamel before applying self-adhesive resin cement.[24]

In clinical follow-up studies, as well as how the restorations are performed, the criteria according to which the restorations are evaluated are critical. In a study evaluating restorations of primary teeth, FDI criteria and 'United States Public Health Service' (USPHS) criteria (known as RYGE criteria), found that the FDI criteria give more accurate results in determining the differences for evaluation of composite resin restorations made in primary teeth.[9] In another study, 36-month evaluations of Scotchbond Universal adhesive were made according to FDI and modified USPHS criteria, and it was found that FDI criteria were more sensitive in detecting small changes.[8]

There was no statistically significant difference between the groups (surface gloss, surface/marginal coloring, anatomical form) except the color matching of the esthetic criteria in our study. Stawarczyk *et al.*[25] compared translucency values in experimental groups with Vita Enamic and Cerasmart materials and found lower translucency values of the Vita Enamic group. This is because Vita Enamic has a large particle size and a large number. In another study using different blocks (CELTRA Duo, Vita Enamic, IPS Empress, Lava Ultimate, IPS e.max CAD, Vita Mark II), Vita Enamic (VITA Zahnfabrik) showed the lowest translucency values. This is due to fact that Vita Enamic contained higher amounts of Al_2O_3 (about 20-23% by weight) than other blocks.[21] In our study, we associated the reason for low color matching in the Vita Enamic group with the above results.

In short-term clinical follow-up studies, the most common cause of failure was reported as restoration fracture and retention loss.[26] In our study, there was no loss of retention, and one fracture occurred in the restoration. Tagtekin *et al.*[27] reported that there was a loss of retention in one restoration after 35 inlay/onlay ceramic restorations on canal-treated teeth that took 6 months of work. They cemented the same restoration again and there was no restoration loss occurred at the end of two years. In the one of the IPS e.max CAD restorations performed in our follow-up study, only fracture requiring correction was observed, which was attributed to the fine finishing of the restoration in that area, and groups were found to be 100% successful.

Indirect restorations to provide an ideal marginal adaptation leads to a less gingival irritation and also less cements dissolution.[28] Therefore, the possibility of microleakage and plaque accumulation decreases, the likelihood of encountering unwanted conditions such as secondary caries, periodontal disease, postoperative sensitivity and marginal discoloration also decreases.[28,29] Hayashi *et al.*[30], as a result of clinical follow-up of 45 inlay restorations using traditional bakable ceramics, observed marginal adaptation of five restorations at the end of two years and six restorations at the end of four years. They reported that marginal adaptation was impaired in a total of 11 restorations (24%) at the end of eight years of control. On the contrary when the restorations performed within the scope of our study which were evaluated in terms of marginal adaptation criteria, after 12 months controls, the Cerasmart group showed 100% success, and acceptable disturbances were seen in three restorations in the E.max group and one restoration in the Vita Enamic group.

Patient satisfaction results were excellent at 12 months of clinical follow-up of all restoration groups. These results show that CAD/CAM restorations are more satisfactory for the patient. Despite the problem of color matching in Vita Enamic restorations, high patient satisfaction suggests that patients do not have high esthetic expectations in posterior restorations.

It is not uncommon for patients who undergo adhesive restorative procedures to experience postoperative sensitivity. Sjögren *et al.*[31] used Vita Mark I and Vita Mark II in their study using CAD/CAM ceramics reported post-operative sensitivity in 10 of 72 patients. Fasbinder *et al.*[32] reported that they had mild postoperative sensitivity in 92% of Vita Mark II onlays in 13% of them at the end of one week and in 4% of them at the end of the second week, but that no patient had postoperative sensitivity at the end of one month. Our study showed similarity with the literature in terms of post-operative sensitivity and when the teeth we restored were evaluated in terms of post-operative sensitivity. One restoration in the IPS e.max CAD group showed slight sensitivity in one week controls, while no restoration sensitivity was observed in the Cerasmart and Vita Enamic groups. No restoration sensitivity was observed in the six month and 12-month controls and all groups were considered 100% successful. The high success rate may be related to our attention to study protocols while preparing the cavity and to the low sensitivity potential of self-adhesive resin systems.

Secondary caries is one of the most important reasons for the failure of dental restorations and has a role in about half of all operative dental procedures performed in adults.[33] In some indirect restoration studies using a CAD/CAM system and followed in different periods, they reported that none of the restorations had secondary caries.[34] As seen in the studies, the risk of secondary caries formation is very low in CAD/CAM restorations. This can be attributed to the fact that the restorations can be made fully compatible with the cavity and the restorations do not have the risk of polymerization shrinkage. Secondary caries formation was not observed in any of the restored teeth in our study.

Tooth integrity weakening as a result of a fracture in healthy teeth under functional forces is rarely seen, but the loss of material created in the cavity preparation weakens the tooth and causes the tendency to break.[35] St-Georges *et al.*[36] reported that 59% of the teeth were weakened when extensive MOD restorations were performed in premolar teeth, and studies have reported an increase in the brittleness of endodontic treated teeth.[37] In the scope of our study, tooth integrity was not observed in any of the restored teeth. In this case, we think that preparing cavities with a tooth wall thickness of at least 2 mm and choosing vital teeth may have an effect.

The periodontal response, in which the compatibility of the restorations with the surrounding tissues is evaluated, plays a vital role in the continuation of the clinical success of the restoration for a long time. Zimmerman's one-year CAD / CAM indirect clinical study showed no signs of gingivitis in forty-eight restorations: '1' had a minimum plaque '2' in 10 restorations, and two restorations scored '3' according to FDI evaluation.[38] In our study, at 12 months, one restoration had '4' in the Cerasmart group, one restoration '3', two restorations '3' in the IPS e.max CAD group, and two restorations '3' in the Vita Enamic group. Since the score '4' indicated the necessity of treatment, the patient was referred to the periodontology clinic. It has been learned that this patient was pregnant, and we think that hormonal changes during pregnancy and less sensitivity to oral hygiene may create such a condition.

CONCLUSIONS

This study shows that CAD/CAM onlay restorations made of porcelain, composite and hybrid blocks have a high clinical success rate after 12 months. Vita Enamic restorations showed significantly lower color matching than Cerasmart and IPS e.max CAD restorations. A more extended clinical evaluation period is required to produce more results.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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