



Clinical Evaluation of Class II Restorations Using Universal Adhesive; 3 Years

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Received Date: September 05, 2024; Accepted Date: September 11, 2024; Published Date: September 18, 2024

Citation: Elif Reyhan Durak, Ali Rıza Cetin, (2024). Clinical Evaluation of Class II Restorations Using Universal Adhesive; 3 Years, J International Journal of Clinical Case Reports and Investigations. 1(2):7, DOI: IJCCRI/RW/007.

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Abstract

The purpose of this study; To retrospectively evaluate the 3-year clinical performance of class II restorations using six different composite restorative materials together with universal adhesives in patients treated. From the voluntary patient group, which included 186 restorations in a total of 105 patients included in the study, 85 patients agreed to come for a control 3 years after the date of procedure, and a total of 141 restorations were evaluated by an only one dentist according to modified USPHS criteria. According to the criteria evaluated in our study, the success rate of dental composite materials was determined as 98.6%. There was no statistically significant difference in clinical success between all dental composite material groups ($p > 0.05$). All dental composite materials used in the study showed clinically acceptable success rates of over 90% as a result of a 3-year retrospective evaluation.

Key words: dental composite materials; modified usphs criteria; retrospective study

Abbreviations

% Percent

nm nanometer

µm micrometer

A Alfa

B Bravo

C Charlie

UDMA urethane dimethacrylate

USPHS United States Public Health Service

Introduction

Dental composite materials are Bis GMA based resins introduced in the early 1960s.¹ This material, which literally means complex materials, consists of synthetic polymers, fillers, dimethacrylate monomers, cross-linked polymers, molecules that initiate the polymerization reaction, inhibitors,

pigments and silane coupling agents.^{2,3} Dental composite materials typically consist of three chemical constituents: organic matrix, inorganic matrix, and intercalating agent.⁴ The inorganic matrix increases the strength of the restorative material and improves the physical properties of the composite by reducing thermal expansion. In

order to increase the mechanical properties of the composite material and reduce its solubility and water absorption, the intercalating agent should provide a strong bond between the organic matrix and the inorganic matrix.³ In current composite resins, the organic matrix structure consists of monomers, co-monomers, inhibitors, polymerization initiators and ultraviolet stabilizers to provide the material with optimum optical, mechanical and clinical properties.^{5, 6} Chewing forces, occlusal habits, abrasive foods and liquids, temperature and humidity changes, bacterial by-

products and salivary enzymes affect the life of composite restorations.⁷ However, results from long-term clinical studies demonstrate the long-lasting success of composite restorations when placed correctly.² Modifications to composite resins improve their physical and mechanical properties. Various shades, translucence, effects and opacities allow today's composites to mimic the optical properties of natural teeth.⁴ Dental composite material classification is as shown Table 1.1.^{8,9}

According to Filler Content and Particle Size	According to Viscosity	According to Polymerization Methods
a) Homogeneous Filled Dental Composites	a) Condensable Composites	a) Chemically Polymerized Composites
Megafil Macrofil Midifil	b) Flowable Composites	b) Visible Light Polymerized Composites
Minifil Microfil Nanofil		c) Both Chemically and Visible Light Polymerized Composites
b) Heterogeneous Filled Dental Composites		

Table 1.1: Dental composite material classification

Composites are commonly divided into three groups according to filler size and inorganic filler distribution; traditional, microfilled and hybrid composites.^{3,10} Traditional composites (macrofil) contain 75-80% by weight and 50-60% by volume inorganic filler.¹⁰ The relatively large size of the filler particles results in the abrasion of the material and the deterioration of its surface properties. To solve this surface irregularity problem seen in traditional composites, dental composite materials with smaller filler sizes have been developed. Microfill composites with an average filler size of 0.01-0.04 μm allow a smoother and more polished surface to be finished. They have an inorganic filler content of 35-60% by weight and have lower physical and mechanical properties than traditional composites. Clinically resistant to abrasion, microfill composites allow restorations to flex with the tooth with their low elasticity modules. Hybrid composites have been developed by combining the positive physical and mechanical properties of macrofill composites with the typical polishable properties of microfill composites. They contain 75-85% inorganic filler by weight.¹¹ These composites, whose particle size is smaller than macro-filled composites and whose particle amount is greater than micro-filled composites, are named according to the large particle size.⁶ They can be used on both front and back teeth.⁴ With recent developments in dental composites, composites containing only nanoscale fillers have begun to be developed. Nanofilled composites contain more nanoparticles and prepolymerized resin fillers as in microfilled composites, in addition to the hybrid composite formulation.¹² Thus, polymerization shrinkage is reduced and mechanical, optical and polishable properties are increased.⁶ During the polymerization reaction, the monomers in the organic matrix become polymers and shrink in

volume. There is no change in the inorganic phase. Therefore, when the ratio of inorganic fillers in the structure of composite resins is increased, the amount of polymerization shrinkage will also decrease.¹³ The incorporation of small fillers such as nanofilled silica particles into the structure of composite resins greatly reduced polymerization shrinkage and stresses in microfilled and hybrid composites.⁶

In vitro studies are carried out to evaluate the biocompatibility of the materials used on tissues and to predict possible possibilities.¹⁴ The fact that the experimental environment is controllable, cheap, easy and repeatable provides insight into problems that may arise in in vivo studies.¹⁵ Prospective or retrospective in vivo studies are performed to monitor the clinical performance of restorative treatments. In the evaluation of these clinical studies, modified USPHS criteria, modified Ryge criteria and FDI criteria with units ranging from excellent to poor can be used.¹⁶

The purpose of this study was to:

- Determine the clinical performance of posterior composite restorations using modified USPHS criteria,
- Examine the clinical survival rates of posterior composite restorations over time.

Materials Methods

Our study includes patients between the ages of 18-25, with acceptable oral hygiene, without any pulpal or periodontal disease symptoms and systemic health problems, and who applied to the restorative dental treatment clinic due to caries. Patients who had any systemic health problems, had deep class II restorations, refused to participate in the study, and were unable to attend follow-up controls were excluded from the evaluation. The power analysis of this study was

performed with the statistical power calculation program (G-Power, ver. 3.1.9.4 F.Paul, Kiel University, Germany) and a total of 141 restorations were included in the study, with a minimum of 15 restorations in each group. The standard procedure followed for restoration construction is;

- Preparation of the cavity should be done with medium-sized green belt diamond roulette bur under water cooling system using high-speed motors,
- Cleaning the caries with tungsten carbide bur after reaching the dentin tissues,
- Isolating the operation area with cotton pads in addition to saliva ejector systems after the caries is completely removed,
- Limiting the restoration area with matrix tape (Super Matt™ Adapt SuperCap Matrix, Kerr, Switzerland or Quickmat DELUXE, Polydentia, Switzerland,) and wedge,
- Applying the universal adhesive system to the cavity with micro brushes according to the

manufacturer's instructions,

- Ensuring polymerization using VALO Cordless (Ultradent, South Jordan, UT, USA) light device,
- Placing the selected composite material into the cavity using the layering method with a maximum thickness of 2 mm with the help of hand tools,
- Lighting each layer from all directions for 20 s,
- After the procedure is completed, articulation paper (RAYDEN INC, North Carolina, USA),
- Correction of the excess with yellow belt diamond finishing burs (60 and 40 m grit) and polishing (Shofu one gloss, Shofu Co, Japan),
- Removal of the oxygen inhibition layer on the interproximal surfaces of all restorations with aluminum oxide belt sanders (ZENIT flex, President Dental, Germany), was determined as follows.

The date of the restorations made with the described procedures (Table 2.1), the adhesive resin and restorative material used during the making were recorded and follow-up groups were created.

Restorative Materials	Manufacturer	Organic Matrix	Inorganic Filler	Filler % (by weight)	Filler % (by volume)	Type
G-Aenial Anterior	GC Corp, Tokyo, Japan	UDMA and Dimethacrylate comonomers (without Bis GMA)	Strontium, Lanthanoid Fluoride, Silica	76%	63%	Microhybrid
Tetric N Ceram Bulk Fill	Ivoclar, Liechtenstein	Bis GMA, Dma, Dimethacrylate Comonomers	Barium Alumina Silicate Glass and Prepolymer Filler	%80 %17 Prepolymer	60%	Nanohybrid (Bulk Fill)
Clearfil Photo Posterior	Kuraray, Japan	Bis GMA, TEGDMA	Silanize Quartz Baryum Camları, Silaniza Kolloidal Silika (3 µ)	86%	70%	Hybrid
Aelite All Purpose Body	BISCO Dental Products, IL., USA	Ethoxylate Bis GMA, Bis GMA	Glass Filler, Amorphous Silica	76%	55%	Microhybrid
Ceram X SphereTec One	Dentsply, Konstanz, Germany	Bis GMA, TEGDMA, UDMA	Barium Aluminum Borosilicate Glass Fillers (1-1.5 µm), Silicon Dioxide Nanofiller (10 nm)	79%	63%	Nanohybrid
Nova Compo N	Imicryl, Konya, Türkiye	Bis GMA, Dimethacrylate, ULS	Barium Glasses, Ytterbium Trifluoride Prepolymer Filler	%78 %18-22 Prepolymer	%59-60	Microhybrid

Table 2.1. Contents and Manufacturers of Composite Resins Used in Restoring Teeth

A total of 105 patients were included in these groups. Three years later, the tooth and restoration surfaces of the patients included in the follow-up process were evaluated according to the Modified USPHS criteria. According to these criteria; stability of the anatomical form, marginal adaptation changes and possible marginal discolorations, whether the patient developed any sensitivity after the procedure, tooth and restoration color harmony, presence of retention areas and secondary caries supported by radiographs were evaluated. The scores of the findings were grouped as follows;

- Alpha (A), clinically excellent success
 - Bravo (B), clinically acceptable success
 - Charlie (C), clinically unacceptable success¹⁷
- All data collected were recorded on the evaluation form together with the dental photographs taken. (Table 2.2)
- Each of the Modified USPHS criterion data obtained from volunteer patients whose teeth were restored using different dental composite materials and included in the study were statistically evaluated in pairs using the Two Proportion Test.

Name-Surname:				
Age:		Number of Teeth:		
Material:				
Restoration Class:		Date:		
			1 Year	3 Years
Anatomical Form	Alfa	Restoration looks like original anatomy		
	Bravo	The anatomically altered restoration does not need to be replaced		
	Charlie	Restoration requiring replacement where dentin is exposed		
Marginal Adaptation	Alfa	Excellent margin continuity		
	Bravo	Restoration detected during examination but not requiring replacement		
	Charlie	Marginal mismatch requiring change		
Marginal Coloration	Alfa	No coloration at the margin		
	Bravo	Superficial margin discoloration		
	Charlie	Deep discoloration progressing to the pulpal direction		
Post-operative Sensitivity	Alfa	No sensitivity		
	Bravo	Moderate sensitivity		
	Charlie	Hypersensitivity		
Color Match	Alfa	No discoloration on the tooth surface		
	Bravo	Clinically acceptable discoloration		
	Charlie	Aesthetically unacceptable discoloration		
Retention Loss	Alfa	No loss of retention		
	Bravo	Clinically acceptable loss		
	Charlie	Clinically unacceptable loss or loss of the entire restoration		
Secondary Caries	Alfa	No secondary caries		
	Charlie	Presence of secondary caries		

Table 2.2: Evaluation Form

Results

Of the volunteer group consisting of 67 female (112 restorations) and 38 male (74 restorations) patients with completed restorations, 54 female (92 restorations) and 31 male (49 restorations) patients agreed to participate in this retrospective study. All patients were interviewed by phone for a 3-year evaluation and were recalled to the clinic. Unfortunately, 15 of the patients could not be reached, and 1 patient in the Nova Compo N patient group was removed from the study group because his restoration was changed due to secondary caries after 1 year. In this study conducted on volunteer

patients, 81% (85 patients) of 186 Class II restorations of 105 patients were reached after 3 years, and 75.8% (141 restorations) of the restorations were re-examined. In the G-aenial Anterior Composite group, 73%, in the Tetric N Ceram Bulk Fill group, 72%, in the Clearfil Photo Posterior group, 60%, in the Aelite All Purpose Body group, 86%, in the CeramX SphereTec One group, and 94% in the Nova Compo N group, re-examination was performed. 141 restorations were evaluated according to the modified USPHS criteria. The number and percentage distribution of the scores obtained by retrospective evaluation of restorations made using different dental composite materials after 3 years are shown in Table 3.1.

1 Year	G-Aenial Anterior (37)			Tetric N Ceram Bulk Fill (50)			Clearfil Photo Posterior (35)			Aelite All Purpose Body (22)			Ceram X SphereTec One (26)			Nova Compo N (16)		
	Alfa	Bravo	Charlie	Alfa	Bravo	Charlie	Alfa	Bravo	Charlie	Alfa	Bravo	Charlie	Alfa	Bravo	Charlie	Alfa	Bravo	Charlie
Anatomical Form	100(37)	0	0	100(50)	0	0	100(35)	0	0	100(22)	0	0	100(26)	0	0	100(16)	0	0
Marginal Adaptation	81(30)	19(7)	0	82(41)	18(9)	0	94(33)	6(2)	0	95(21)	5(1)	0	96(25)	4(1)	0	94(15)	6(1)	0
Marginal Coloration	100(37)	0	0	100(50)	0	0	89(31)	11(4)	0	100(22)	0	0	96(25)	4(1)	0	94(15)	6(1)	0
Postoperative Sensitivity	100(37)	0	0	100(50)	0	0	100(35)	0	0	100(22)	0	0	100(26)	0	0	100(16)	0	0
Color Match	70(26)	30(11)	0	98(49)	2(1)	0	97(34)	3(1)	0	91(20)	9(2)	0	100(26)	0	0	62(10)	38(6)	0
Retention Loss	100(37)	0	0	100(50)	0	0	97(34)	3(1)	0	100(22)	0	0	100(26)	0	0	94(15)	6(1)	0
Secondary Caries	100(37)	0	0	100(50)	0	0	100(35)	0	0	100(22)	0	0	100(26)	0	0	94(15)	0	6(1)

3 Years	G-Aenial Anterior (27)			Tetric N Ceram Bulk Fill (36)			Clearfil Photo Posterior (21)			Aelite All Purpose Body (19)			Ceram X SphereTec One (23)			Nova Compo N (15)		
	Alfa	Bravo	Charlie	Alfa	Bravo	Charlie	Alfa	Bravo	Charlie	Alfa	Bravo	Charlie	Alfa	Bravo	Charlie	Alfa	Bravo	Charlie
Anatomical Form	81(22)	19(5)	0	75(27)	25(9)	0	95(20)	5(1)	0	100(19)	0	0	87(20)	13(3)	0	73(11)	27(4)	0
Marginal Adaptation	63(17)	37(10)	0	72(26)	28(10)	0	81(17)	19(4)	0	95(18)	5(1)	0	91(21)	9(2)	0	100(15)	0	0
Marginal Coloration	78(21)	22(6)	0	100(36)	0	0	81(17)	19(4)	0	95(18)	5(1)	0	91(21)	9(2)	0	87(13)	13(2)	0
Postoperative Sensitivity	89(24)	7(2)	4(1)	100(36)	0	0	100(21)	0	0	100(19)	0	0	96(22)	4(1)	0	100(15)	0	0
Color Match Retention Loss	56(15)	44(12)	0	92(33)	8(3)	0	95(20)	5(1)	0	68(13)	32(6)	0	74(17)	26(6)	0	60(9)	40(6)	0
Secondary Caries	96(26)	4(1)	0	92(33)	8(3)	0	95(20)	0	5(1)	100(19)	0	0	100(23)	0	0	100(15)	0	0

* The parentheses represent the number of restorations

Table 3.1: Percentage Distribution of Restorations Evaluated According to Modified USPHS Criteria *

When the restorations in our study were evaluated according to the modified USPHS Criteria; in the anatomical form examination, the clinically acceptable B score was seen more in the G-Aenial Anterior Composite group among five different dental composite materials. In the Aelite All Purpose Body group, all restorations were recorded as A score. In the marginal adaptation evaluations, the highest B score was seen in the G-Aenial Anterior Composite and Tetric N Ceram Bulk Fill groups. All restorations in the Nova Compo N group were recorded as A score. The highest B score for marginal discoloration value was seen in the G-aenial Anterior Composite and Clearfil Photo Posterior groups, while the Tetric N Ceram Bulk Fill group received the highest A score. The only C score for postoperative sensitivity was detected in the G-aenial Anterior Composite group, and there was no difference between the Tetric N Ceram Bulk Fill, Clearfil Photo Posterior, Aelite All Purpose Body and Nova Compo N groups, and A score was recorded in all restorations. In the color match evaluation, the highest B scores were detected in the G-aenial Anterior Composite and Nova Compo N groups. For retention loss, C score was recorded only in one restoration in the Clearfil Photo Posterior group. There was no difference between the Aelite All Purpose Body, CeramX Spheretec One and Nova Compo N groups, and all restorations were recorded as A score. In the secondary caries evaluations, C score was recorded in the G-aenial Anterior Composite and Ceramx Spheretec One groups. There was no difference between the Clearfil Photo Posterior, Aelite All Purpose Body and Nova Compo N groups, and all were recorded as A score.

Discussion

The overall clinical success of dental composites is multifactorial, therefore a series of in vitro and in vivo studies are needed.¹⁸ The results obtained from in vitro studies are informative about the clinical performance of the dental composite materials used.¹⁹ With the in vivo studies and standard evaluations, the healthiest possible restorations are made in the patient's mouth.²⁰

Clinical follow-up is required at certain periods to evaluate the success of the materials used and the restorations made in dentistry.²¹ Studies indicate that the long-term performance of materials will deteriorate over time at marginal edges, regardless of the placement technique.¹⁹ In addition to the fact that the long-lasting clinical success of restorations made with dental composite materials in both the anterior and posterior regions is related to various factors related to the operator and the material, the most important factors to be considered are appropriate placement techniques and the optimum level of polymerization. It has been stated that the success rate of materials with improved mechanical and physical properties will increase.²² In accordance with the changing conditions in the oral environment, the properties of dental composite materials such as thermal expansion coefficient, elastic modulus and water absorption should exhibit similar behavior. Hybrid composites with increased inorganic filler ratio that meet these conditions are preferred in posterior restorations.²¹ Standard programs such as the USPHS criteria and the ADA acceptance program continue to be used today for routine clinical evaluations. However, "modified USPHS criteria" have been developed that include additional parameters such as postoperative sensitivity and surface properties.¹⁷

Studies have shown that the location of the restoration plays a role in the formation of secondary caries. It has been found that under optimum oral hygiene, cervical composite restorations (class V) are the least affected by secondary caries, while the highest incidence of secondary caries is in class I and class II restorations made in the posterior region.²³ In our study where we used modified USPHS evaluation criteria, in restorations made in class II cavities, the secondary caries formation percentage was determined as 4% in two dental composite materials (G-aenial Anterior composite and CeramX SphereTec One) at the end of three years.

Dental composite materials are tooth-colored and are exposed to components in the oral environment such as saliva and food. It is desired that the

restorations maintain their color stability under these conditions.²⁴ In the in vitro study conducted by Hatırlı et al., color change was detected at varying rates in all restorative materials and it was found that the most affected restorations were those made with microhybrid composites.²⁵ Similarly, in our study, we observed that the restorations with higher Bravo scores that remained within clinically acceptable limits were in the microhybrid composite G-aenial Anterior, Aelite All Purpose Body and Nova Compo N groups.

In the study by Furness et al., marginal compatibility of bulk fill composites and conventional composites with enamel and dentin tissue showed similar results.²⁶ In our study, we found that hybrid composites with fillers of different sizes maintained their anatomical form within clinically acceptable limits and gave Alpha and Bravo values for marginal adaptation and coloration.

Depending on the preference of the dentist, universal adhesives can be used in restoration construction in total etch, self-etch, and selective etch modes. Burke et al. did not etch in their study, considering the sensitivity that may occur in the dentin after etching, and recommended selective etching of the enamel if deemed necessary.²⁷ In our study, restorations made with universal adhesives in self-etch mode were examined in order to prevent postoperative sensitivity. In restorations made in class II cavities including dentin tissue, no sensitivity was observed in any restoration after one year, while postoperative sensitivity was detected in only one restoration (G-aenial Anterior group) after three years.

In the study conducted by Josic et al. using universal adhesives; retention loss was found to be successful regardless of the application mode at 6 months follow-up, while statistical differences were shown at 12, 18 and 24 months follow-up. Higher retention loss was detected in the self-etch application mode compared to the total etch

application mode group.²⁸ In our study, while we did not observe any retention loss in the restorations after the application in self-etch mode at the end of one year, we noted retention loss in one restoration (Clearfil Photo Posterior group) after three years.

Conclusions

In our study where we evaluated the restorations retrospectively, we found that the dental composite materials used were clinically successful according to the Modified USPHS criteria, and when all criteria were evaluated, a total success rate of 98.6% was achieved. The life of the restorations depends on many factors such as the patient's oral hygiene, caries susceptibility, and the materials and techniques used. The patients evaluated in our study had good oral hygiene, no caries formation or periodontal problems, which explains the high success rates of the restorations. In line with the first aim of this study, as a result of the statistical evaluation of the data obtained from the Modified USPHS criteria, it was observed that there was a difference in Bravo scores between dental composite materials. Secondly, it was seen that the data obtained from all dental composite materials used in the study remained at the level of clinical acceptability and there was no clinical difference between the restorations.

Composite resins, which are in widespread clinical use, are successful and open to development. More studies monitoring the survival rates of restorations in the mouth will guide understanding the nature of the material and making tooth-like restorations.

Acknowledgments

I would like to thank my professors at Selçuk University Faculty of Dentistry, Department of Restorative Dentistry, all my friends who helped me during the study, and my family who was always with me.

Conflicts of Interest

The authors declare no conflicts of interest

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