Clinical Evaluation of Posterior Resin Composite Restorations Placed by Dental Students of Kuwait University

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Key Words

Posterior resin composite restorations • Clinical evaluation • Retrospective study • Dental students

Abstract

Objective: To investigate the survival rate over a 3-year period of posterior resin composite restorations placed by dental students of Kuwait University. **Materials and Methods:** Posterior resin composite restorations placed by 5th-, 6th- and 7th-year dental students between 2004 and 2005 were evaluated. All patients with posterior composite restorations placed during this period of time were recalled. Of the 204 eligible patients, 139 attended the recall. 432 posterior resin composite restorations were evaluated clinically and radiographically according to the United States Public Health Service criteria. For each restoration, the survival time and/or reasons for failure were recorded. Descriptive statistics and logistic regression analysis were used to analyze the data at a statistically significant level of $p < 0.05$. **Results:** At 3 years, the survival rate of the restorations was 95.1%, resulting in an annual failure rate of 1.7%. Recurrent caries was the most common cause of failure (71.4%). Oral hygiene and gender and age of the patient were the factors that affected the failure rate of the restoration ($p < 0.05$). Other factors such as tooth type and location, type of cavity, type of liner used and level of the student who performed the procedure

did not affect the failure rate ($p > 0.05$). **Conclusion:** Dental students of Kuwait University were able to place resin composite restorations in posterior teeth with a low annual failure rate. Recurrent caries was the most common cause of failure of posterior resin composite restorations. Oral hygiene was the most important factor in determining the survival of resin composite restorations.

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Introduction

Resin composite and amalgam are both considered as suitable direct restorative materials for class I and class II cavities [1]. An obvious advantage of the resin composite materials is the minimum amount of sound tooth tissue that has to be removed to restore primary carious lesions [2]. It has also been documented that resin composite restorations strengthen the remaining tooth structure more than amalgam restorations do [3]. Moreover, resin composites present a very low thermal conductivity [4]. For these reasons, resin composite materials have been increasingly used as a direct restoration in posterior teeth. Such restorations become the first choice in case of primary caries as well as a suitable replacement of small and moderate-sized amalgam restorations [5].

Table 1. Specifications of the materials and instruments used in the study

Material	Composition	Manufacturer
OptiBond Solo Plus, single-component dental adhesive	Ethyl alcohol, dimethacrylate resins, barium aluminoborosilicate glass, silicon dioxide, sodium hexafluorosilicate	Kerr Corporation, Orange, Calif., USA
Prodigy Condensable, dental restorative material	Methacrylate monomers, titanium dioxide, zinc oxide, pigments	Kerr Corporation
Heliomolar, microfilled, radi-opaque restorative material	Dimethacrylates, copolymer, silicon dioxide, ytterbium trifluoride, catalysts, stabilizers and pigments	Ivoclar Vivadent, Schaan, Liechtenstein
GC Fuji Lining LC, light-cured glass ionomer lining material	Polyacrylic acid, 2-hydroxyethyl methacrylate, distilled water, aluminosilicate glass	GC Co., Tokyo, Japan
Ultra-Etch, etchant	35% phosphoric acid	Ultradent Inc., South Jordan, Utah, USA
Optilux 501	Halogen curing light	Kerr Corporation

At dental schools worldwide, there is a change from teaching amalgam as the only restorative material for class I and II cavities to a trend in which more emphasis is placed on the use of resin composite restorations [6]. However, it has been found that the indications, contraindications and techniques taught for posterior composite restorations vary widely among dental schools [7].

Recurrent caries has been reported as the most common cause of failure of posterior resin composite restorations [8]. Other reasons for failure include fracture, insufficient proximal contact, color mismatch, marginal discoloration, loss of the anatomic form, and loss of marginal adaptation [9].

The clinical program of the Faculty of Dentistry, Kuwait University, started in 2002. Students began seeing patients in their 5th year of a seven-year program. The program is based on comprehensive dental care education where students complete the treatment planning of the case, then start with preventive and periodontal treatment before they start the restorative treatment. The aim of this retrospective study was to investigate the longevity and the reasons for failure of posterior resin composite restorations placed by students at the clinics of the Dental School of Kuwait University in the years 2004 and 2005 over a three-year follow-up period.

Materials and Methods

For this retrospective clinical study, file numbers of all patients with posterior resin composite restorations placed by 5th-, 6th- and 7th-year dental students between September 2004 and

September 2005 were retrieved from students' log books. Patient files were checked and all eligible patients were called for a follow-up visit. The exclusion criterion was a medical history that could affect the posterior resin composite restoration.

All restorations were placed by dental students under the supervision of a staff member according to a fixed protocol. The protocol included the following steps in sequence: local anesthesia and rubber dam isolation; cavity preparation following a conservative design; placement of light-cured glass ionomer cement as a liner under the restoration in case of deep cavities; metal matrix band and wooden wedge application in case of a class II cavity; acid etching with 37% phosphoric acid for 15 s, rinsing and drying while leaving the dentin moist; application of a dentin-bonding agent and light curing for 20 s; incrementally restoring the cavity with resin composite and light curing each increment for 40 s; finishing and polishing of the restoration; finally, checking of the occlusion and proximal contacts. The restorative materials used in the study are presented in table 1.

The evaluation of the restorations was carried out by 2 graduating dental students at the same visit. Prior to the investigation, a calibration of both examiners was undertaken on 10 patients (not included in the study) until a complete inter- and intraexaminer reliability was achieved (100% agreement). During calibration, the 2 examiners were supervised by a faculty staff member whose specialty is operative dentistry. At each examination visit, and before the patient left, the 2 examiners compared their results and if they were found to be different, they would repeat the examination together to reach a consensus [1, 10]. The clinical evaluation of all the restorations was performed under dental operating light using a front-surfaced mouth mirror and a dental explorer. In case of a class II restoration, a bitewing radiograph was taken before the clinical evaluation. The investigators evaluated the color match, marginal discoloration, marginal adaptation (restoration retention/fracture), recurrent caries (cavitations or softness to probing) and anatomical form according to United States Public Health Service (USPHS) criteria [11]: Alfa = restorations of satisfactory quality and meeting all clinical standards with a range of excellence; Bravo = satisfactory restorations,

Table 2. Results of the evaluation of the restorations according to the USPHS criteria (n = 432)

	Alfa	Bravo	Charlie	Delta
Color	339 (79.2)	89 (20.8)	0 (0)	–
Marginal discoloration	384 (89.7)	42 (9.8)	2 (0.5)	–
Anatomy	389 (90.9)	39 (9.1)	0 (0)	–
Marginal adaptation	345 (80.5)	75 (17.6)	8 (1.9)*	–
Recurrent caries	413 (96.5)	0 (0)	15 (3.5)	–
Missing or fractured	–	–	–	4 (0.9)
Total	231 (53.5)	180 (41.6)	17 (4.0)	4 (0.9)

Values are numbers with percentages in parentheses. * Restorations evaluated as Charlie for marginal adaptation were also evaluated as Charlie for recurrent caries.

though not ideal, with a range of acceptability; Charlie = restorations of unacceptable quality having to be replaced or corrected for preventive reasons. A Delta score was assigned when the restoration was found to be mobile, fractured or missing. Restorations with a Charlie or Delta evaluation were considered failures and the reason for the failure was documented. After examining the restoration(s), the teeth were stained with a disclosing solution, and the presence or absence of plaque was determined on all teeth surfaces. The patients' oral hygiene was determined as good or poor based on their plaque score. A patient with a plaque score of 30% or above was considered as having good oral hygiene. The patients' age and gender were recorded. In addition, the tooth type (premolar or molar), tooth location in the oral cavity (upper or lower), restoration type (class I or class II), the type of liner that was used before the restoration and the level of the student who performed the procedure were also documented.

The files of 204 patients with class I and class II posterior composite restorations placed in the period of September 2004 till September 2005 were screened. The patients ranged in age from 13 to 78 years (mean: 29 ± 3.8 years), and had a total of 630 posterior composite restorations (class I: 436; class II: 194).

The mean annual failure rate of the investigated restorations was calculated according to the formula $(1 - \gamma)^3 = (1 - x)$, in which γ expresses the mean annual failure rate and x the total failure rate at 3 years [12]. The data were statistically analyzed using stepwise multivariate logistic regression at a statistically significant level of $p < 0.05$ with SPSS Software, version 16 (SPSS, Chicago, Ill., USA).

Results

After contacting all the patients, 139 (68%) came for the checkup examination; 58 (41.4%) were females and 81 (58.6%) were males. There were 432 restorations that met the inclusion criteria of this study distributed to class I (279; 64.6%) and class II (153; 35.4%). There were more

Table 3. Distribution of the results of the evaluation (success/failure) of the restorations according to different variables

	Number	Evaluation, %	
		success	failure
Age, years			
≤15	34	85.3	14.7
16–30	257	96.9	3.1
31–45	124	96.8	3.2
>45	17	76.5	23.5
Gender			
Female	179	92.7	7.3
Male	253	96.8	3.2
Oral hygiene			
Poor	303	93.3	6.6
Good	129	99.2	0.8
Tooth type			
Upper molar	122	94.3	5.7
Upper premolar	110	94.4	3.6
Lower molar	144	95.1	4.9
Lower premolar	56	94.6	5.4
Jaw			
Upper	232	95.3	4.7
Lower	200	95.0	5.0
Type			
Class I	279	95.7	4.3
Class II	153	94.1	5.9
Liner			
Adhesive only	217	95.4	4.6
Glass ionomer	167	96.4	3.6
Calcium hydroxide + glass ionomer	48	89.6	10.4
Year			
Fifth	114	93.0	7.0
Sixth	276	95.7	4.3
Seventh	42	97.6	2.4
Total	432	95.1	4.9

occlusal carious cavities restored with resin composite than with amalgam, whereas for class II carious cavities, if the margin of the cavity was below the cemento-enamel junction, the students were usually asked to place an amalgam restoration. The reasons for the dropout varied: some of the patients were outside Kuwait during the recall (7%), some patients could not be contacted (10%) and the other 15% just did not want to attend the recall.

After clinical evaluation, 231 restorations (53.5%) were rated as Alfa in all the clinical criteria, while 180 (41.6%) were rated as Bravo in at least 1 of the clinical criteria examined. Of the 432 restorations, 21 (4.9%) were rated as Charlie or Delta in at least 1 of the clinical criteria and considered to be a failure. Therefore, the annual failure

Table 4. Results of multivariate logistic regression analysis

	Estimate	OR	95% CI	P
Age, years				
≤15	0.746	0.529	0.089–3.161	0.079
16–30	–0.701	0.444	0.225–0.877	0.019
31–45	–0.897	0.408	0.173–0.963	0.041
>45 (R)	–	–	–	–
Gender				
Female	1.093	2.982	1.178–7.540	0.021
Male (R)	–	–	–	–
Oral hygiene				
Poor	2.202	9.046	1.021–19.751	0.014
Good (R)	–	–	–	–
Tooth type				
Upper molar	0.145	1.156	0.572–2.339	0.686
Upper premolar	–0.333	0.717	0.310–1.658	0.436
Lower molar	–0.191	0.826	0.391–1.617	0.610
Lower premolar (R)	–	–	–	–
Jaw				
Upper	0.056	1.057	0.439–2.544	0.901
Lower (R)	–	–	–	–
Type				
Class I	–0.165	0.848	0.544–1.322	0.467
Class II (R)	–	–	–	–
Liner				
Adhesive only	–0.878	0.415	0.135–1.277	0.125
Glass ionomer	–1.138	0.320	0.093–1.100	0.071
Calcium hydroxide + glass ionomer (R)	–	–	–	–
Year				
Fifth	0.546	1.726	0.746–3.993	0.203
Sixth	0.038	1.039	0.466–2.318	0.925
Seventh (R)	–	–	–	–

The dependent variable was failure. Variables were dummy-coded. R = Reference in the regression analysis model.

rate was calculated to be 1.7%. The reasons for failure of the restorations were as follows: 15 cases of recurrent caries (71.4%), 4 (19.1%) missing restorations and 2 (9.5%) deep marginal discolorations. Eight restorations (38%) had a poor marginal adaptation, but they all had recurrent caries as well (table 2).

The distribution of the evaluated restorations according to patients' age, gender and oral hygiene is presented in table 3. The same table also shows the distribution of the restorations according to tooth type and location, classification of the restoration, type of the liner used, and the level of the student who performed the procedure. The results of the multivariate logistic regression analysis are given in table 4. Patients in the age groups of 16–30 and 31–45 years had a lower failure rate than pa-

tients younger than 15 years, and a lower rate than patients older than 45 years (OR: 0.44 and 0.40; 95% CI: 0.22–0.87 and 0.17–0.96). Furthermore, female patients had higher failure rates than male patients (OR: 2.9; 95% CI: 1.17–7.54). The failure rate of resin composite restorations among patients with poor oral hygiene was 9 times that of patients with good oral hygiene (OR: 9.0; 95% CI: 1.02–19.75). On the other hand, there was no statistically significant difference in the failure rate among different tooth types, or between upper and lower teeth, between class I and class II cavities, between different types of liners and between students of different levels ($p > 0.05$).

Discussion

The results of this study indicate that 53.5% of the entire colored posterior teeth restorations were rated as Alfa in all the evaluation criteria, while 41.6% of the restorations were rated Bravo in at least one of the evaluation criteria. The total failure at three years was 4.9%, with the main reasons for the failure of the restorations being recurrent caries (71.4%) and the loss of marginal adaptation (19.1%). These results are similar to those of other studies performed in similar settings, i.e. dental schools [12, 13]. Other studies [14, 15] showed a lower survival rate either due to the difference in the materials used or due to the fact that these studies were done in general dental practice clinics compared to ours where it had been done in a dental school setting.

Patients less than 15 years old or more than 45 years old had higher failure rates than the other age groups. Regarding the young group, the type of the food they preferred at this age and the fact that the teeth were not fully mature might have contributed to the fact that they were more prone to recurrent caries [16]. For older individuals, research indicates that recurrent caries is more prevalent among this age group [17]. In addition, this age group usually has more missing teeth and more dental prostheses, which makes it more difficult for them to clean their teeth well [16].

The result of our study shows that the failure rate among females was three times higher than the failure rate for males. The reason for this difference can be attributed to the fact that most of the female patients at the Kuwait University Dental Clinics are either housewives or housemaids. It has been documented that there is a difference in dietary pattern between housewives and working men [18]. In addition, female patients in general are known to be more prone to dental caries than males [19].

Regression analysis showed that the most important factor associated with the success of the restorations was the patients' oral hygiene. This is not surprising since the most common cause of failure of the restorations was recurrent caries shown to be due to poor oral hygiene and plaque accumulation [16, 20, 21]. These results should be taken into consideration before the placement of a posterior resin composite restoration in a patient with poor oral hygiene.

In agreement with a previous study [21], there was no statistically significant difference in the failure rate between class I and class II cavities in this study. Other studies found the failure rate for class II restorations to be higher than that for class I restorations [1, 12, 22, 23]. The reason for the difference between the results of our study and the results of these studies is the strict protocol we follow for class II resin restorations. If the gingival floor of the cavity is below the cemento-enamel junction, we ask the students to place amalgam rather than resin composite restorations.

Furthermore, in agreement with a previous study [21], we found no difference in the failure rate between restorations placed in different types of teeth. On the contrary, other studies reported higher failure rates for restorations placed in molars than for those placed in premolars [22, 23]. Again, the reason for this different finding might be the strict protocol for the placement of posterior composite restorations that has been followed in our clinics, where only small cavities on molars are restored with resin composite restorations.

In this three-year study, the mean calculated annual failure rate of 1.7% for restorations placed by the dental students approximated the failure rate (0.7–5%) reported by similar studies [1, 8–10, 12]. In our study, all patients were treated by operators with limited clinical experience, while, on the other hand, most of the other studies were done with calibrated and experienced operators (not dental students), and the patients were often specially selected. Studies done on general dental practice reported a higher annual failure rate (about 7%) than the one we found in our study [17, 24, 25].

A limitation of this study is the small number of patients, which reflects the small number of students, approximately 20 students in each academic year. However, the method of direct clinical evaluation using USPHS criteria gives an impression of the quality of posterior composite restorations placed by dental students.

Conclusion

This retrospective clinical study showed that dental students of Kuwait University were able to place resin composite restorations in posterior teeth with a low failure rate. Recurrent caries was the most common cause of failure, and the patients' oral hygiene was the most important factor in determining the longevity of posterior resin composite restorations.

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