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Survival Rate of Direct Posterior Composite Resin Restorations at a Southern California Dental School

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ABSTRACT

Background: The study's purpose was to assess the survival rates and associated factors affecting posterior composite resin restorations placed by dental students at a Southern California Dental School (SCDS).

Methods: Retrospective data from patient records were reviewed, including direct composite resin restorations placed on posterior permanent teeth from January 2018 to April 2018. Data analysis included patient age, gender, number of surfaces, primary reason for restoration, method of isolation, and reasons for failure. The longevity of the restorations was evaluated by the Kaplan–Meier survival analysis, with detailed at-risk tables provided for each subgroup, significance was set at alpha = 0.05.

Results: The search yielded 792 patient records (57% female and 43% male, age range: 18–99) with 1,457 restorations. Overall, the 1-year survival rate was 91%, while the 5-year survival rate reduced to 86%. The log-rank test identified that Age group ($p = 0.004$) was the only variable with a statistically significant effect on the survival rates of dental procedures. Younger patients (<30) had markedly lower survival probabilities, while those in the 51–70 age range showed the highest.

Conclusions: We conclude that the 5-year survival rate of direct composite resin restorations in posterior teeth placed by dental students was 86% and therefore deemed acceptable. The survival rate was impacted by age, highlighting the importance of considering age when assessing procedural risk and expected outcomes, particularly those under the age of 30.

Practical Implications: This retrospective study provides useful insights into the longevity of composite restorations in a dental educational setting.

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Dental education; posterior composite resin restorations; survival rate; retrospective study

Introduction

Dental caries continues to be a disease that disproportionately affects people worldwide.[1] As such, most of the dentists' operating time is taken up by restorative operations due to an excessive demand for these procedures.[2] Resin composite materials are increasingly used for direct restorative procedures. Along with restoring the form and function of the posterior teeth, resin composite materials also restore the aesthetics of the anterior teeth. For these reasons, understanding and determining the potential longevity of direct resin composite restorations is crucial. The longevity and failure rate of resin composite restorations has been reported in retrospective practice-based studies,[3–5] and through systematic reviews of randomized controlled trials.[6–8] However, there is scarce information on the longevity of resin composite restorations performed by dental students under the supervision of faculty in academic institutions.

It is well known that there are several patient-level, individual tooth-level, and operator-level factors that play crucial roles in determining the long-term success of the restoration.[9,10] The dental school environment provides a good opportunity to further evaluate these factors as many times a limited number of resin composite material and bonding systems are used. Thus, the purpose of the study was to evaluate the survival rates of direct posterior composite resin restorations performed by dental students under the guidance of faculty members at a Southern California Dental School (SCDS) over a period of five years. Additionally, we aimed to identify the primary reasons for placing the restoration and identify the importance of various factors that may affect survival. We hypothesized that several factors, including patient demographics, primary reason for restoration, number of surfaces included in the restoration, and method of isolation, would not significantly impact the five-year survival rate of these posterior composite resin restorations.

Materials and Methods

Institutional Review Board and Data Collection

The Institutional Review Board of a Southern California Dental School approved the study involving retrospective data review from an academic dental software (axiUm, Exan

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software, Las Vegas, NV) (IRB #5230349). Access to axiUm records was obtained from the clinic administration for records that met the inclusion and exclusion criteria.

Inclusion & Exclusion Criteria

The inclusion criteria for this study focused on composite resin restorations placed specifically on posterior permanent teeth between January 1, 2018, and April 30, 2018. Eligible records were of patients aged 18 years or older and received treatment in the main clinic by either third- or fourth-year dental students. The restorations were classified under the following procedure codes: D2391, D2392, D2393, and D2394, representing white dental fillings applied to one, two, three, or four surfaces of posterior teeth, respectively. Treatments included both initial restorations and the replacement of existing ones, with no distinction made between the two.

For each patient record, the patient's birth year, gender, and the number of teeth treated during the specified time period were documented. Records that were incomplete, duplicated, or involved restorations using indirect or provisional materials were excluded from the analysis. Additionally, any records involving deciduous (primary) teeth or teeth that had undergone endodontic (root canal) therapy were not included in the study sample.

Type of Materials Used

During the time period of this retrospective review, the adhesive and composite materials used in the main clinic were 3 M™ Scotchbond™ Universal Adhesive (3 M, Saint Paul, MN) and Filtek™ Supreme Ultra (3 M), respectively. Students were taught to prepare the cavity based on maintaining as much healthy tooth structure as possible, as the bonding process provides sufficient retention. If the preparation is deep, applying a liner or base, is recommended to protect the pulp.

Data Extraction and Assessment of Longevity

Records were further populated on an Excel spreadsheet and three student investigators entered data on: Primary reason for restoration, method of isolation, and reason for failure if any over a follow-up period of 5 years. The assessment of the longevity of restorations followed a methodology established by da Silva Pereira.[4] Three student investigators were trained on reviewing axiUm records and the methodology for recording success and failure of the restoration. Restorations in posterior teeth were considered successful if they were not planned for replacement during their next periodic and comprehensive oral examinations over a follow-up period of 5 years. Restoration failure was identified when teeth required indirect rehabilitation treatment, restoration replacement, endodontic treatment, tooth fracture repair, or extraction.[4]

Statistical Analysis

Descriptive analyses were performed on the frequencies of demographics (age and gender), procedure type of restoration, primary reason for restoration, method of isolation, and reasons for failure. The longevity of the restorations was evaluated by the Kaplan–Meier survival analysis, with detailed at-risk tables provided for each subgroup. Failure rates were calculated based on the primary reason for restoration over a five-year period to provide a summary of restoration failure rate by year. Multivariable Cox Proportional Hazards (CoxPH) modeling was used to assess the influence of various factors on restoration failure, using frailty to account for clustering by patient. A frailty term was incorporated into the CoxPH model to account for the correlation of multiple restorations performed on the same patient. We stratified the model by Age Group to account for variations in baseline hazards between age categories. The model was then run with and without the frailty term for comparative analysis, and the model with the frailty term is presented in the paper. Hazard ratios (HR) and 95% confidence intervals (CI) were reported for all covariates. Log-rank and generalized log-rank tests were performed for comparisons between groups. Statistical inferences were made based on a 5% significance level for all tests. Data were analyzed using Python v3.12.4 (Lifelines Library, version 0.27.4).[11]

Results

Descriptive Analysis

The dataset comprised 792 patient records with 1,457 posterior composite resin restorations. The patient ages ranged from 18 to 99 years (Mean = 51.98, Standard Deviation = 18.56). Descriptive analyses are summarized in Table 1. The gender distribution was fairly even, with 57.1% females and 42.9% males. The treatments were performed on teeth across all positions (Tooth Numbers 1 through 32). When categorizing teeth as premolars or molars, premolars comprised 51.7% of the restorations in the posterior region, while molars made up 48.6%. The data on restoration types by the number of surfaces showed that the most common restoration was a one-surface composite resin filling (54.3%), followed by two-surface (32.7%), three-surface (11.2%), and four-surface fillings (1.8%). Primary caries was the most common reason for placing the restoration (57.8%). The most common method of isolation used was rubber dam (43.4%). Despite the fact, that rubber dam placement is mandated in the student main clinic when placing direct composite resin fillings, other types of isolation such as the use Mr. Thirsty, Isolite, and cotton rolls were commonly used and documented.

Survival Distribution Among Different Categories

The log-rank test was used to compare survival across different categories of patient gender, age group, procedure type, and isolation method. Age group ($p = 0.004$) was the only variable with a statistically significant effect on the survival rates of dental procedures. Younger patients (<30) had markedly lower survival probabilities, while those in the 51–70 age range show the highest. Pt_Gender ($p = 0.471$), Quadrant ($p = 0.526$), Procedure_Type ($p = 0.319$), and Primary Reason for Restoration ($p = 0.314$) did not show significant associations with survival rates, suggesting these factors do not substantially influence procedural longevity. Isolation ($p = 0.063$),

Table 1. Summary of descriptive analyses.

	Frequencies (N)	Percentage (%)
Gender		
Male	340	42.9
Female	452	57.1
Universal Tooth Number		
1	10	0.7
2	90	6.2
3	87	6
4	84	5.8
5	97	6.7
12	103	7.1
13	80	5.5
14	76	5.2
15	65	4.5
16	13	0.9
17	10	0.7
18	83	5.7
19	76	5.2
20	105	7.2
21	97	6.7
28	95	6.5
29	90	6.2
30	88	6
31	94	6.5
32	14	1
Number of Tooth Surfaces		
One-surface restoration	791	54.3
Two-surface restoration	477	32.7
Three-surface restoration	163	11.2
Four-surface restoration	26	1.8
Primary Reason for Restoration		
Primary Caries	842	57.8
Secondary Caries	322	22.1
Chipping/Fracture	63	4.3
Non-Carious Cervical Lesions	166	11.4
Other	64	4.4
Method of Isolation		
Rubber Dam	633	43.4
Mr. Thirsty	240	16.5
Isolite	40	2.7
Cotton rolls/Dry angles	488	33.4
Optragate	6	0.4
Other	50	3.5

while not statistically significant, was close to the threshold and may have a minor impact on survival rates.

Failure Rates by Primary Reason for Restoration

The failure rates over a five-year period are summarized in Table 2. Primary caries was the most common reason for restoration need (see Table 1), and the analysis showed an initial high failure rate of 19.4% (95% CI: 9.6%–29.1%) in the first year, which then dropped to 8.3% by the second year (95% CI: 1.5%–15.2%). This suggests that primary caries restorations may face early challenges but tend to stabilize in later years. By the fifth year, the failure rate reached 0.0%, indicating no recorded failures during this period, which suggests long-term durability once initial risks are managed. Non-carious cervical lesions displayed a progressive increase in failure rates over the 5 years. The failure rate begins at 11.9% (95% CI: 8.4% –15.4%) in the first year, slightly increasing to 12.2% (95% CI: 8.7%–15.8%) by the second year. However, by the fourth year, the failure rate rose significantly to 18.2% (95% CI: 14.0% –22.4%), and by the fifth year, it reached 21.4% (95% CI: 17.0%–25.9%). This trend suggests that restorations for non-carious cervical lesions may deteriorate over time, possibly due to ongoing exposure to environmental or biomechanical factors that affect longevity. Overall, the 1-year survival rate was 91%, while the 5-year survival rate reduced to 86%.

Hazard Ratios (HR), 95% Confidence Intervals (CI), and P-Values for All Covariates in the CoxPH Model

The multivariable Cox Proportional Hazards analysis revealed the following associations: Procedure Type (HR = 0.93, 95% CI: 0.87–1.02), Pt_Gender (HR = 1.01, 95% CI: 0.87–1.18), and Isolation Method (HR = 0.96, 95% CI: 0.89–1.05). Full model results are presented in Table 3.

Kaplan–Meier Survival Curves by Procedure Type (Number of Surfaces Included)

The survival analysis and risk table based on the number of surfaces included is illustrated in Figure 1. Four-surface composite resin restorations (2394) had the lowest survival rate as compared to other posterior composite resin restorations. The one-surface (2391) and two-surfaces (2392) composite resin restorations showed the higher survival probability over 5 years.

Table 2. Five-year failure rates and confidence intervals by primary reason for restoration.

Year	Primary Reason For Restoration	Failure Rate	Lower 95% CI	Upper 95% CI
1	Primary Caries	0.194	0.096	0.291
	Secondary Caries	0.064	0.027	0.101
	Chipping/Fracture	0.077	0.059	0.095
	Non-Carious Cervical Lesions	0.119	0.084	0.154
	Other	0.050	−0.005	0.105
2	Primary Caries	0.083	0.015	0.152
	Secondary Caries	0.000	0.000	0.000
	Chipping/Fracture	0.095	0.075	0.115
	Non-Carious Cervical Lesions	0.122	0.087	0.158
	Other	0.000	0.000	0.000
3	Primary Caries	0.143	0.056	0.229
	Secondary Caries	0.194	0.135	0.254
	Chipping/Fracture	0.145	0.121	0.169
	Non-Carious Cervical Lesions	0.119	0.084	0.154
	Other	0.091	0.019	0.163
4	Primary Caries	0.111	0.034	0.189
	Secondary Caries	0.045	0.014	0.077
	Chipping/Fracture	0.095	0.075	0.115
	Non-Carious Cervical Lesions	0.182	0.140	0.224
	Other	0.417	0.293	0.540
5	Primary Caries	0.000	0.000	0.000
	Secondary Caries	0.100	0.055	0.145
	Chipping/Fracture	0.117	0.095	0.139
	Non-Carious Cervical Lesions	0.214	0.170	0.259
	Other	0.300	0.185	0.415

Table 3. Hazard ratios (HR), 95% confidence intervals (CI), and p-values for all covariates in the CoxPH model.

Variable	Coefficient	Hazard Ratio	SE Coefficient	Z Score	p-value	Lower 95% CI	Upper 95% CI
Pt_Gender	0.0077	1.0077	0.0904	0.0851	0.9322	0.8441	1.2031
Procedure_Type	0.0199	1.0201	0.0469	0.4244	0.6713	0.9305	1.1184
Primary Reason	0.0073	1.0073	0.0504	0.1449	0.8848	0.9126	1.1119
Isolation	0.0003	1.0003	0.0238	0.0117	0.9907	0.9547	1.0481
Quadrant	−0.0292	0.9712	0.0290	−1.0076	0.3137	0.9175	1.0280

Procedure Type: Number of surfaces included.

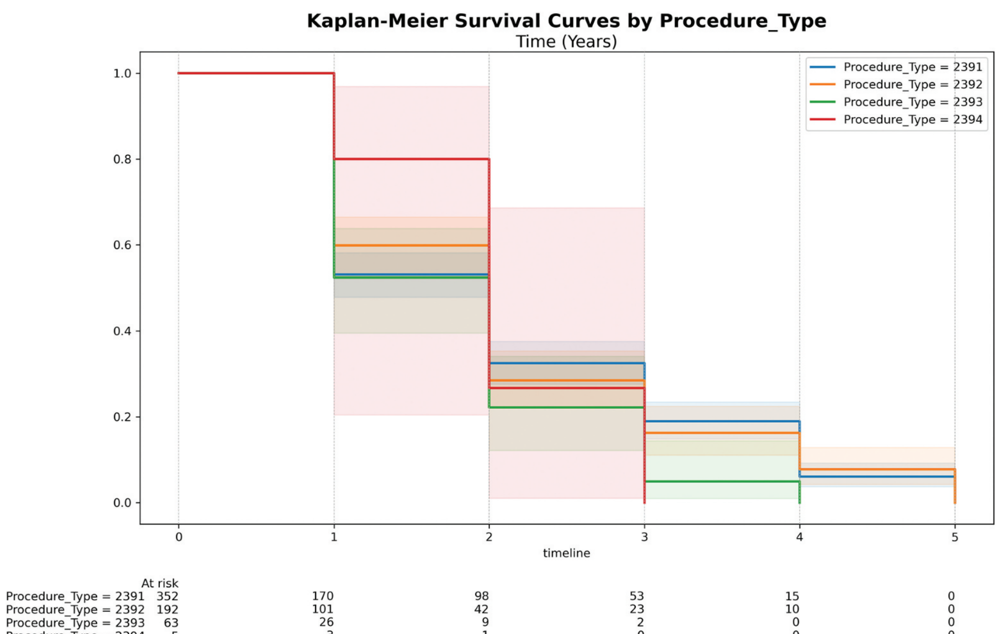

Figure 1. Kaplan–Meier survival curves by procedure type (number of surfaces included). *Procedure type 2391: one-surface posterior restoration; 2392: two-surface posterior restoration; 2393: three-surface posterior restoration; 2394: four-surface posterior restoration*

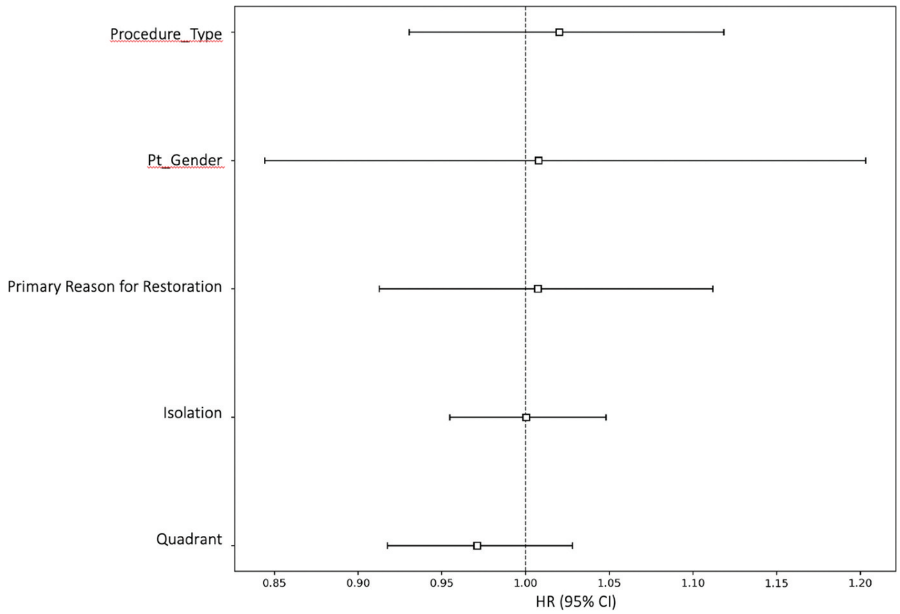

Figure 2. Forest plot of hazard ratio by category.

Forest Plot

The forest plot in Figure 2 provides a visualization of the hazard ratios, ensuring both frailty and non-frailty models are clearly indicated. All factors (Procedure_Type, Pt_Gender, Primary Reason for Restoration, Isolation, and Quadrant) had hazard ratios close to 1, with confidence intervals that crossed 1. None of these factors had a statistically significant impact on the risk of failure or survival in the context of this model.

When reviewing the notes on reported failures of composite resin restorations, recurrent decay was the most common reason for failure followed by open margin and fracture.

Discussion

Teaching the placement of posterior direct composite resin restorations is a well-established element of dental students' training in the curriculum. Yet, data on the survival rate of composite resin restorations placed by undergraduate students in dental schools are still rare.[12,13] The outcomes of the current study showed that the longevity assessment of posterior direct composite resin restorations placed by dental students demonstrated good performance, with a 5-year survival rate of 86%. It is noteworthy that the survival rate surpassed the 5-year survival benchmark of 80%, which is considered a quality control indicator at the Southern California Dental School. Our results are in close accordance with another retrospective study that reported an 87% survival rate over five years of posterior composite resin restorations placed by dental students at a Dental School in the Netherlands.[14] A recent study at a Brazilian Dental School reported a 12-year survival rate of 78% for posterior composite resin restorations placed by dental students.[13] Considering that the restorations were placed by inexperienced dental students, the use of composite resin in posterior teeth can be deemed acceptable. However, the survival rate was lower than the approximately 94% four-year survival rate and the 84% eight-year survival rate reported for experienced dentists.[4,15] A systematic review concluded that while restorations placed by students had shorter longevity compared to those by experienced dentists, the outcome was more dependent on the skill of the operator than on the student's level of experience.[16]

Based on the results we rejected our hypothesis that several factors, including patient demographics, primary reason for restoration, number of surfaces included in the restoration, and method of isolation, would not significantly impact the five-year survival rate of these posterior composite resin restorations. The log-rank test identified that "age: was a variable with a statistically significant effect on the survival rates of dental procedures with younger patients exhibiting markedly lower survival probabilities. This emphasized the importance of considering age when assessing procedural risk and expected outcomes, with potential adjustments or precautions for high-risk age groups, particularly those under 30 years. Isolation, while not statistically significant, was close to the threshold and may have a minor impact on survival rates. It was unexpected to find that despite its mandate, only about 40% of cases utilized rubber dam isolation. This may be due to the fact that there is no strong evidence supporting the use of rubber dam in increasing the longevity of restorations which is in accordance with our study results. A systematic review indicated there was some low-certainty evidence suggesting that using rubber dam during dental direct restorative treatments might result in lower restoration failure rates compared to using cotton rolls after 6 months.[17] In contrast, the relationship between the number of surfaces and longevity has been reported by numerous studies suggesting that the larger the composite restoration, i.e., more tooth surfaces involved, the lower the long-term survival probability of a restoration.[6,10,12,18]

Another important aim of the study was to identify the primary reason for placement of direct composite resin restorations. Primary caries was the most common reason highlighting the importance of preventive measures to fight the chronic disease still affecting adults at various ages. The second most common reason was due to secondary caries necessitating the removal of the existing restoration. However, based on the treatment codes used, it was not clear whether a replacement or a repair was performed. Lastly, it was observed that recurrent decay was the most common reason for the failure which is in accordance with other studies.[14,19–23]

The study results are significant in advocating the use of direct composite resin restorations in the posterior region at academic dental institutions. At the same time, it is important to note several limitations of the study. As a retrospective data review, success and failure was based on whether the restoration was replaced or not. There was no clinical evaluation on the acceptability of the quality of the restoration. Furthermore, the absence of data on the student's year and individual caries risk, which could further explain some of the observed variability. Future studies should consider collecting such information to provide a deeper understanding of the influence of operator experience on restoration success.

Conclusion

Within the limitation of the study, we conclude that the evaluation of axiUm dental records at a Dental School in Southern California showed that the 5-year survival rate of direct composite resin restorations in posterior teeth placed by dental students was 86% and therefore deemed acceptable. The survival rate was impacted by age highlighting the importance of considering age when assessing procedural risk and expected outcomes, particularly those under the age of 30.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

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