Review Article

Longevity of Posterior Composite Restorations and Their Reasons for Failure: A Systematic Review

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Abstract

The decision-making process determines how long repairs last. Recent evidence suggests that other variables have a predominant impact on the clinical efficacy of composite restorations, as the current restorative composites are not the issue anymore. Age, caries and occlusal stress risk, socioeconomic position, and occupational characteristics (gender, clinical experience) may be some of these. Using databases including PubMed, Medline, and ScienceDirect, a systematic review of the literature spanning 2010 to 2022 was conducted. "Posterior composite," "longevity of composites," and "composite failure" were the main phrases employed. The PRISMA flow chart shows the procedure for selecting articles to be searched. The quality of the included studies was assessed using the Cochrane method for assessing the risk of bias. A total of 9 studies were incorporated after thorough screening and a majority of them revealed highly satisfactory longevity and lower failure rate of posterior composite restorations. composites can be successfully placed for posterior cavities, whereas, the operator's experience and the use of fiber post are the most significant factors in determining the longevity.

Keywords: Posterior composite, Longevity, Factors, Failure, Systematic review

Introduction

The use of resin-based composite materials to restore posterior teeth is becoming increasingly common among doctors, and customers are demanding more cosmetic restorations. Resin composite is, in fact, the most popular cosmetic substitute for dental amalgam. But the failure rates, recurring caries, and replacement frequency of moderate to large posterior composite restorations are greater [1-3].

The decision-making process determines how long repairs last. In the past, most research focused on the therapeutic efficacy of various composite materials. More recent data suggests that other variables have a predominant impact on the clinical efficacy of composite restorations as the current restorative composites seem not to be the issue anymore. Age, caries and occlusal stress risk, socioeconomic position, and professional characteristics (gender, clinical history) may be some of these. Identifying risk indicators and outlining their primary causes may make it easier for dental professionals to decide on restoration treatments, which would enhance the lifespan of restorations and save expenses [4-6].

Direct composite resin restorative materials (composites) have become the material of choice for the repair of posterior teeth since they also allow for a less invasive technique. thanks to rising patient demand for aesthetically pleasing tooth-colored dental restorations, advancements in the properties of composite resin systems, and the worldwide phase-down of the use of dental amalgam. Along with modern composites' superior aesthetic properties, their repairability and the ability to reinforce the remaining tooth structure make this treatment method advantageous. As a result, the restored teeth are better able to withstand functional loading and have a better prognosis than untreated teeth [7].

Maintaining patient confidence and the trust of third-party payers like the National Health Service (NHS) in the United Kingdom depends on the success of posterior composites [8]. When determining how long a dental restoration will last, it is useful to look at how long it has been since the last restoration or other intervention on the same tooth. A similar definition of failure is when the same tooth needs

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another restoration, repair, or intervention [9].

When it comes to posterior composites, there are a lot of moving parts that may affect how well they function. This includes both the patient and the dentist or oral surgeon. A number of recent global surveys on the teaching of posterior composites have shown that dental students have found minimally invasive techniques and composites to be viable and predictable alternatives to dental amalgam in teeth. Similarly, it has been shown that it believes it can be used for partial restoration. The implantation of composites as definitive restorations in the posterior teeth are taught in several dental schools exclusively. With a mean yearly failure rate of 2.8% for posterior composites, it has been established that dental students may obtain acceptable clinical outcomes [10, 11].

PICO Question

P: Patients with posterior composite restorations.
I: Composite restoration
C: Restorations other than composite
O: Longevity of restoration

Aims of the Study

The purpose of this systematic review was to determine the longevity of posterior composite restorations and their reasons for failure.

Materials and Methods

A systematic review of the literature from 2010 to 2022 was performed using databases such as PubMed, Medline, and ScienceDirect. "Posterior composite," "longevity of composites," and "composite failure" were the main phrases employed **(Table 1)**. The procedure for choosing the articles to be searched was shown by a PRISMA flowchart **(Figure 1)**.

Table 1. Inclusion and exclusion criteria for the studies

Inclusion criteria	Exclusion criteria
Case-control and randomized control studies	Meta-analyses, narrative reviews, systematic reviews, or expert opinions
Published between 2010 and 2022	outside of the time frame indicated
Studies including posterior composite restorations	studies including non-composite restorations
English language of publication	a language besides English
In vivo (humans)	In vitro

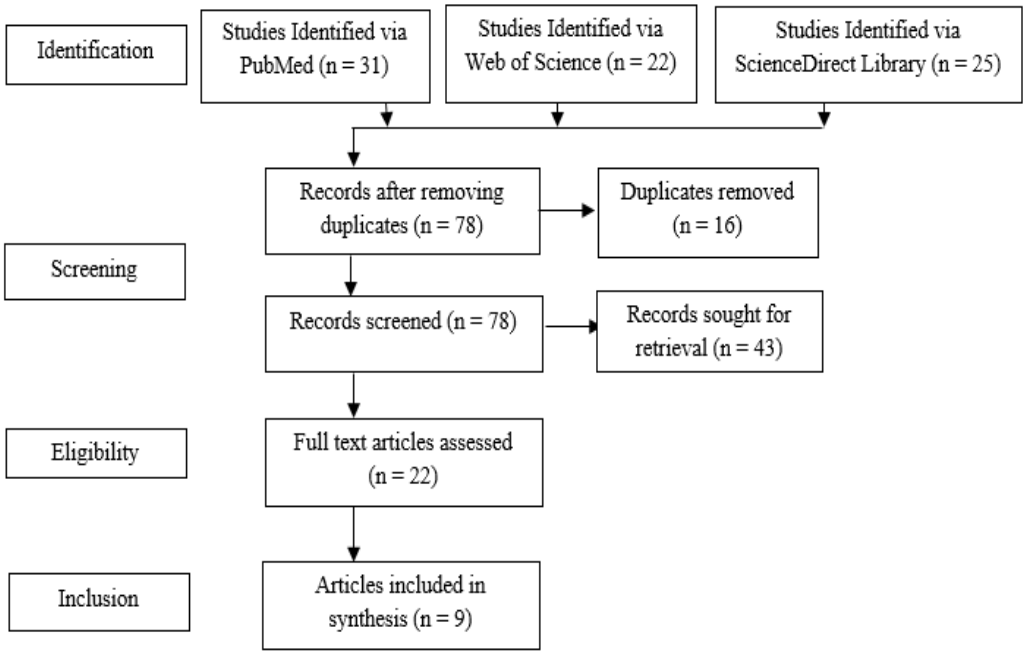

Figure 1. PRISMA Flow Diagram

Risk of Bias Assessment

The Cochrane risk of bias assessment method was used to assess the quality of the studies included **(Table 2)**.

Table 2. Summary of Cochrane Risk of Bias Assessment

Study	Selection Bias/Appropriate control selection/baseline characteristics similarity	Selection bias in randomization	Selection bias in allocation concealment	Performance-related bias in blinding	Reporting bias/Selective reporting of outcomes	Detection bias Blinding outcome assessors	Accounting for confounding bias
[12]	+	+	+	+	+	+	-
[13]	+	+	+	+	+	+	-
[14]	+	+	+	+	+	_	+
[15]	+	+	+	+	+	+	-
[16]	+	+	+	+	-	+	+
[17]	+	+	+	-	+	+	+
[18]	+	+	+	+	+	+	+
[19]	+	-	+	+	+	+	-
[20]	+	+	+	+	+	-	+

Results and Discussion

Through prospective follow-up research, Pallesen *et al*. (2013) reported that postoperative sensitivity occurred in 2% of restorations using the base material and 1% of restorations without the foundation material [12]. Replacements were a part of 456 restorations, while 125 restorations comprised repairs. According to Kaplan-Meier analysis, the cumulative survival rate after eight years was 84.3%, with a 2% annual failure rate. Younger patients, those with many restorations per patient, those with a base material installed, and those with RC placed on molars, in cavities with many surfaces, or lower jaw teeth all exhibited noticeably higher failure rates. The age of the patient, age of the operator, shape of the jaw, type of tooth, and size of the cavity all significantly impacted the replacement or repair of the resin composite restorations. The annual failure rates of posterior RC restorations in kids and teens who had treatment at Public Dental Health clinics were comparable to those seen in randomized controlled RC studies of adults, suggesting strong durability.

The aim of the study by Wong *et al*. (2021) was to investigate the dental, patient, and operator characteristics that influenced the survival rate (time to re-intervention) of composite restorations in posterior teeth among patients seeking treatment in a primary care dental outreach setting over 11 years [13]. Electronically collected information on primary dental care for specific patients, including dental treatment, sociodemographics, and service delivery. A total of 1086 individuals had at least one posterior composite implanted over those years. Throughout the 11-year research period, 3,194 repairs were completed, and 308 needed more work. After one year, 16.78 percent, five years, and 10 years, the average annual failure rate for restorations was 5.73 percent, 16.78 percent, and 18.74 percent, respectively. According to a logit regression analysis, the first and second most poor quintiles were 49.2% (p = 0.022) and 53.2% (p = 0.031) less likely to get a re-intervention than the fifth quintile, which had the lowest poverty level.

Between 1995 and 2005, 24 dentists implanted resin composite restorations in 97 patients (mean age 58) at Nagasaki University Hospital, and Kubo *et al*.'s (2011) study examined the factors associated with these restorations' endurance [14]. All patients had been under the care of the lead investigator (SK) for 11 years, during which time most of them received regular checks. Ten-year survival rates for the SK group were 84.2%, compared to 71.8% for the other groups, showing a statistically significant difference. Age and gender at placement did not affect survival time, but retreatment risk did. It was discovered that the survival of conventional 2-step etch-and-rinse and 2-step self-etch adhesives with and without prior enamel etching did not differ considerably. Although the type of the tooth was inconsequential, the variety of cavities significantly impacted it.

Determining the cumulative survival rates of class II resin-based composite and compomer restorations in primary molars during a 5-year observation period was the study's main goal by Pummer *et al*. (2020) [15]. The secondary goal was to examine how different anesthetics and restorative locations affected these survival percentages. One random restoration was allocated to each patient older than six at the time of placement. Results There were 260 repairs, of which 57% were composites, and 43% were resin-based composites. After five years, there was no statistically significant difference in the cumulative survival rates of restorations made with resin-based composite and those made with polymer. A greater chance of survival existed for

restorations placed under general anesthesia or N2O inhalation sedation. Compared to those implanted mesially, composite restorations placed distally had significantly poorer survival rates (p = 0.003).

Montagner *et al*. (2018) carried out two distinct analyses for the investigation: 1) clinical examination of 30 patients by inspecting restorations (n = 123) to examine clinical features and failure type distribution, and 2) dental electronic records of 100 patients (n = 333) to assess factors affecting survival [16]. Patients ranged in age from 21 to 76, making the average age of the group 55. This retrospective study examined the frequency, causes, and factors influencing the durability of composite restorations after being implanted by undergraduate students. Compared to posterior restorations, the AFR was different for anterior restorations (p=0.005). Several variables, including income (p0.001), caries activity (p0.001), caries risk (p0.001), and occlusal risk (p0.001), had an impact on the effectiveness of restorations. According to patient risk variables and tooth position inside the dental arch (anterior restorations failed more often than their posterior counterparts), first-year dental students' restorations had an acceptable AFR after eight years. After eight years, restorations placed by undergraduate students had a decent AFR; however, the AFR was influenced by the patient's risk factors and the tooth's position in the arch (anterior restorations failed more often than posterior restorations).

Laegreid *et al*. (2012) performed a study on the relevance of the extent of the restorations and other factors related to their performance [17]. Patients ranged in age from 25 to 76 years old (mean 43.9 years). Between the baseline and the 1- and 3-year recall, every clinical criterion showed a clinical score change. Nine restorations were deemed inadequately functional after three years; for these nine restorations, the three-year survival rate was 87.7 percent, and the mean annual failure rate was 4.2 percent. Age, caries risk, restoration extension, or cervical enamel presence were all shown not to substantially impact restoration survival, except gender (p = 0.022). The clinical performance of extensive direct posterior composite restorations was judged to be good after three years. Males had a far greater incidence of restoration failure than females did.

After 36 months, Kitasako *et al*.'s randomized controlled study compared the clinical effectiveness of a highly filled flowable composite to that of a traditional paste-type composite in direct posterior restorations. The outcome was that 21 patients had 42 restorations evaluated after 36 months. In terms of any of the evaluation criteria, it was shown that after 36 months, there was no statistically significant difference between highly filled flowable and conventional restorations (p > 0.05). There was no sign of secondary caries. The highly filled flowable composite was proven to be just as therapeutically advantageous as the conventional paste composite after 36 months of usage in posterior restorations.

In this randomized controlled trial, Loguercio *et al*. (2019) compared the clinical success rates of the two bonding methods for posterior composite resin restorations: self-etch (SE) and etch-and-rinse (ER) [19]. Both methods were used for 36 months. All participants were adults (over 18) with a complete set of posterior teeth in occlusion; none were getting orthodontic treatment at the time. 72 people (n = 236) with posterior dental cavities at least 3 millimeters deep were randomly allocated to one of four groups. The repairs were bonded using Tetric N-Bind ER and Tetric N-Bond SE. Tetric N-Ceram Bulk-Fill, a composite resin, was introduced using IF or BF. Using FDI criteria, two qualified examiners evaluated the restorations at the beginning, at 12, 24, and 36 months. The Wilcoxon Signed Rank test (p=0.05) was used for the statistical analysis. 14 restorations out of 36 months had minor fractures, 21 had marginal adaptations, and 33 had color mismatches (p > 0.05). In 33 restorations (3 for ER-IF and 3 for ER-BF; p 0.05), marginal darkening significantly differed between ER and SE at 36 months.

The retrospective research by Scotti *et al*. (2015) compares the survival rates of teeth repaired with fiber posts vs [20]. direct resin composite without cusp covering after endodontic treatment. It was predicted that direct restorations using fiber posts would fare better than those without. However, this hypothesis was investigated and shown to be incorrect. The Department of Cariology and Operative Dentistry at the University of Turin saw the participants between 2008 and 2011. 247 patients who had received direct resin composite restorations for 376 posterior teeth and undergone root canal treatment were contacted for follow-up. In Group A, there were 128 patients, 68 males, and 60 women, with a mean age of 46.2%. After 178 teeth—88 premolars and 90 molars—had been observed for a median of 34.44 months, they were examined. The 119 patients in Group B had an average age of 48.7 years. In this group, there were 65 ladies and 54 males. The condition of 198 teeth (92 premolars and 106 molars), which had been under surveillance for an average of 35 months, was evaluated. Direct restorations with fiber posts were statistically more successful (95.12% success) than those without fiber posts (80% success) because they had better marginal discoloration, marginal integrity, and restoration integrity. After three years of chewing, direct post-endodontic restorations with fiber posts functioned better than restorations without posts. The null hypothesis was thus accepted **(Table 3)**.

Table 3. Summary of the included studies.

Author's name	Participants	Age (years)	Observation period (years)	Objective	Results
Pallesen *et al*., (2013) [12]	2881	13.7 mean age	8 years	The goals of this research were (1) to determine how long patients' posterior resin composites (RC) last in their permanent teeth, and (2) to examine the durability of composite restorations in the back teeth in terms of time to re-intervention.	Kaplan-Meier estimates that the yearly failure rate is 2% based on the cumulative longevity rate of 84.3% after 8 years.
Wong *et al*., (2021) [13]	1086	21.7	11-year		After one year, 16.78% of restorations had failed, after five years, 18.74% had failed, and after 10 years, the annual failure rate for all restorations was 5.73%.
Kubo *et al*., (2011) [14]	97	58 mean ages	11 years	The goal of this study is to delve into the factors that affect the durability of resin composite restorations.	Ten-year longevity of 84.2% was significantly higher than the rest at 71.8%.
Pummer *et al*., (2020) [15]	260	6 years	5 years	The major purpose of this study was to evaluate the long-term success of resin-based composite restorations in primary molars, classified as class II.	Survival rates for distal-occlusal composite restorations were significantly lower than those for mesial-occlusal restorations ($p = 0.003$).
Montagner *et al*., (2018) [16]	130	55 mean age	8	This retrospective research aimed to examine the AFR, failure causes, and predictors of composite restoration longevity both in the rear and anterior regions of the mouth.	Patient risk variables and tooth location in the arch were associated with an acceptable AFR for restorations put by undergraduate learners after 8 years, with anterior restorations failing more often than posterior restorations.
Laegreid *et al*., (2012) [17]	42	25 to 76 years	1 to 3 years	The purpose of this study was to evaluate the clinical efficacy of large-scale direct composite restorations in molars.	Patients' age, caries risk, restoration length, and the existence of cervical enamel were all considered, however only gender ($p = 0.022$) was shown to significantly affect restoration survival.
Kitasako *et al*., (2016) [18]	32	43.9 years	36	To compare the clinical efficacy of a highly filled flowable composite to that of a standard paste-type composite for direct posterior restorations, this randomized controlled trial was conducted.	There was no statistically significant difference between strongly filled flowable and conventional restorations across all assessment criteria ($p > 0.05$).
Loguercio *et al*., (2019) [19]	72	At least 12 and 18	36 months	This study aimed to assess the clinical efficacy of the layering strategy to the conventional way when restoring posterior teeth with composite resin.	There was a statistically significant difference between ER and SE in the amount of marginal discoloration present after 36 months in 33 restorations ($p = 0.05$).
Scotti *et al*., (2015) [20]	247	46.2 mean age	35 months	The purpose of this study is to evaluate the durability of direct resin composite restorations on endodontically treated teeth.	Direct restorations with fiber posts were statistically significantly more successful (95.12% success) than those without fiber posts (80% success) due to decreased marginal discoloration, improved marginal integrity, and increased restoration quality.

However, amalgam was still employed to replace posterior teeth in the early 1990s, whereas RC was mainly used for front teeth. After suggestions from many nations to switch from using amalgam to alternative restorative materials, a significant shift in material preference began in Scandinavia in the late 1990s. This led to an increase in the number of posterior teeth treated with RC. Estimation of all data was used to calculate the RC—restorations' survival time.

After eight years, there was an 84% survival rate, translating to a 2% annual failure rate. This offers a useful contrast with earlier findings of yearly failure rates in randomized long-term longitudinal studies ranging from 0.5% to 3%. The average lifetime of common restorations is overestimated in cross-sectional research, according to a review by Downer *et al*. Two investigations showed a weak association between the prospective failure rates and the survival rates reported in a cross-sectional study, which concentrated on recovering

teeth that have already been replaced. While the age of the restorations in several pieces of research had been based on barely 60% of the restorations evaluated, ranging from 25% to 79%, the low recording response rates of general practitioners in these studies made lifespan numbers even more questionable [12].

Evaluations by the directing clinical professors and their students were used to assess whether restorations in this research were successful or unsuccessful. Although difficult to avoid in practice-based research due to potential observer bias, this depicts the real clinical context and should be considered. It is also important to note that the clinical instructors who evaluated most of the restorations were not the same people who implanted them. This bonus may help doctors determine whether or not reintervention is necessary [21].

It has been hypothesized, and it is primarily recognized, that the operator's proficiency significantly impacts the durability of restorations. However, there has been a lack of clinical research to support this theory. Resin composite restorations were predicted to have a ten-year survival rate of 84.2%, higher than the 71.8% expected by the other 23 dentists. Class II and Class V restorations, often more difficult, showed the most significant difference across operator groups. In contrast to the other dentists' group, 80% of the failed restorations were replaced by colleagues [22].

The current research's conclusions on lifespan are inconsistent with those of retrospective investigations; nonetheless, one study demonstrated increased survival rates. When comparing the cumulative survival rates of resin-based composites after one year between the current research and the one by Blum *et al*. (2018), the latter exhibited a survival rate of 88% [23]. In contrast to our results of 3.1 years of 50% survival for resin-based composites, Zahdan *et al*. (2018)'s research found 2.9 years [24]. There were statistically significant differences between resin-based composites and traditional glass ionomers and resin-modified glass ionomer cement for class I and II restorations of posterior primary teeth in another retrospective investigation evaluating the lifetime of these three materials. In our research, 46% of patients survived after four years, but 62% of patients with resin-based composites did [23-25].

It has been shown that dental students' restorations have a shorter life expectancy than regular dentists. This conclusion may be explained by the fact that previous operator experience matters for the success of the restoration. However, in this research, operator skill (as opposed to experience) was shown to have a greater impact on restoration success than the undergraduate student's experience (as measured by years of study/practice).

However, the operator's competence to do restorations may not be an advantage if the examiner's training to make repair or replacement decisions by general dentists is based on criteria that may contradict the scientific facts [12, 26, 27].

According to the present analysis, the restorations had an annual failure rate (AFR) of 4.2%. Another study that compared the 12-year durability of substantial composite vs. amalgam restorations found that the composite restorations had a lower AFR (3% for patients with a high caries risk and 0.88% for those with a low cavity risk). Sixty percent of the composite tooth restorations had three Class II surfaces, whereas the remaining had four or five surfaces. In this study, only 8% of the restores had only three surfaces; the majority had four or five [28].

How effectively the restorative material is bonded together using an adhesive approach impacts how long the repair will last. The bonding substance used in this study had a remarkable success rate, with over 97% of the restorations remaining in place after eight years of clinical service. According to this investigation, the marginal staining was mostly superficial and could be easily fixed by further finishing and polishing [29, 30].

The bulk fill technique's most popular material was discovered to have excellent mechanical properties after thirty-six months of clinical testing, as shown by a decreased proportion of restorations with fractures or failures at interaction sites or in the restoration margins. Since there was only a 5.4%–7.2% absolute chance of fracture, these changes were not clinically significant [31].

In this research, 2.44 percent of restorations had coronal fractures, yet the tooth could be saved in every instance. This data demonstrates that the use of fiber posts may help minimize the incidence of coronal fractures and, even in fracture situations, may encourage a restorable fracture pattern. In vitro research by CAMPOS *et al*., 2012 found similar findings, indicating that post-placement was strongly linked to more desirable fracture patterns. Another in vitro investigation by shown that direct restorations with linked fiber posts enhanced the incidence of recoverable fractures in endodontically treated premolars with MOD cavities, but direct restorations without posts resulted in the majority of fractures being irreparable [8].

Conclusion

The overall failure rate of posterior composite restorations was found to be ranging from 2% to 6%, which is acceptable and concludes that composites can be successfully placed for posterior cavities. Regarding the factors associated with longevity, the operator's experience and the use of fiber posts are the most significant factors in determining longevity.

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