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Clinical Behavior of Cl IV Direct Composite Restorations

Research Article

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Abstract

Objective: The aim of this study, based on individual participant data from several studies, was to investigate the influence of materials related to Failure of class IV direct resin composite restorations and reason of failure. We conducted a search resulting in 5 longitudinal studies of class IV direct resin composite restorations with follow-up between two to twenty years. Main reasons for failure were luck of retention and fracture.

Materials and Methods: This is a review study. The research sources utilized were PubMed, Google scholar, MEDLINE and Complutense university Library. The keywords which were selected based on Medical Subject Heading (MeSH) terms and PICOS criteria were Class IV Direct Composite Restoration , Failure of Class IV Direct Composite Restoration, longevity of Class IV Direct Composite Restoration and survival rate of Class IV Direct Composite Restoration. For the period from 2010 to 2019. The number of subjects who restored with Nano filled resin composite (FiltekSupream) was 12, 13 subjects restored with Nano hybrid (Ceram X Duo), 13 subjects restored with polyacid modified resin composite (compomer), 7 subjects restored with resin-modified glass ionomer cement, 8 subjects restored with universal composites (Herculite XR), 16 subjects restored with universal composites (Charisma), 7 subjects restored with Highly Filled Hybrid Composite (TPH), 11 subjects restored with non specific resin composite and 2 subjects restored with microhybrid composite, Amaris (Voco).

Results: Nanofilled resin composite (FiltekSupream) and Nano hybrid (Ceram X Duo) both have the same longevity between two to five years in direct class IV composite, loss of restorations for lack of retention and fracture of restorations is the main reason of failure for both.

Universal composites (Herculite XR) the most reason of failure in this type of composite is the anatomic form change, in the other hand, universal composites (Charisma) the esthetic reasons are the main reasons of failure. Both of them have long longevity until fifteen years.

Polyacid-modified resin composite (compomer) and resin-modified glass ionomer cement have the same reason of failure that is restorations fracture in seven year more or less.

Highly Filled Hybrid Composite (TPH) and microhybrid composite, Amaris (Voco) loss of restoration for lack of retention is the main reason of failure for both. However, they have short longevity between two to three years.

Conclusion: Three things decide the success rate, the survival rates and the longevity of direct class IV composite restorations, the dentist, the material and the patient. The study show failure reasons for different composite risen materials and the longevity. Fracture of restorations and loss of restorations for lack of retention are the most failure reasons. Patients must be educated about the expected life of these restorations as well as their advantages and disadvantages, so they can make an informed decision on a treatment option. There is lack of information about the longevity, survival rates, failure reasons of class IV direct composite in last 10 years. This study evaluate the reason of failure regarding to the studies that we showed.

Introduction

The first tooth-colored composite was silicate cement, which was introduced in 1870s. This composite formulation was based on alumino-fluro-silicate glasses and phosphoric acid. However, were brittle, required mechanical retention, and had an average longevity of only a few years [1]. Then first polymeric tooth-colored composite used was based on polymethylmethacrylate, this material was developed in the 1940s, Although these materials were initially esthetic, they were plagued with a variety of problems, including poor color stability, high polymerization shrinkage, a lack of bonding to tooth structure, and a large coefficient of thermal

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expansion (CTE) [1]. Then the first polymer matrix composite incorporating silica fillers was introduced in the 1950s. These composites had improved mechanical properties and good esthetics; However, did not bond to tooth structure, and still exhibited significant polymerization shrinkage. In addition, there was no significant bonding between the silica particles and the polymer matrix. Consequently, these composites did not have good wear resistance clinically, because the filler particles were easily dislodged [1].

Composite classify according to their filler characteristics, such as chemical composition, shape, and especially particle size. Depend on the size of filler particles and their size distribution like microfills, hybrids, packables, and compomers. In addition, subclassifications, including flowables, and nano- and microhybrids [1]. Composites with smaller filler particles prevent the wear of the resin matrix and minimize the surface alteration deriving from the particles' detachment [2]. Composite have been changed, in an attempt to achieve the best possible mechanical properties while maintaining esthetics. Changes in restorative treatment patterns improved restorative materials and techniques, effective preventive programs, enhanced dental care, and growing the longevity of dental restorations [3].

Restoration of anterior tooth fractures is a common dental procedure. Both direct and indirect options are clinically acceptable to repair fractured teeth. Anterior tooth fractures are usually result of sporting activities or accidents and tend to occur more often on the maxillary incisors [4].

In the 1970s, degradation or wear was considered the main reason for failure of composite restorations. Then Twenty years later, studies revealed secondary caries to be the new cause of failure [1].

The aim of this study, based on individual participant data from several studies, was to investigate the influence of materials related to Failure of class IV direct resin composite restorations and reason of failure. We conducted a search resulting in 5 longitudinal studies of class IV direct resin composite restorations with follow-up between two to twenty years. Main reasons for failure were luck of retention and fracture.

Material and Methods

Description of search strategy of relevant literature.

Objective

The objective of this study was to evaluate reasons of failure in direct composite class VI restorations.

Criteria for considering studies (PICO)

The studies considered for inclusion in this review include case series, cohort studies, and randomized clinical trial studies (Table 1).

Search Strategies

The PubMed (MEDLINE) database, Universidad de Complutense Library and Google scholar. The keywords were selected based on Medical Subject Heading (MeSH) terms and PICOS criteria. The keywords for search included: Class IV Direct Composite Restoration, Failure of Class IV Direct Composite Restoration, longevity of Class IV Direct Composite Restoration and survival rate of Class IV Direct Composite Restoration. To avoid any missing article, the references of each selected manuscript was rechecked manually through Mendeley Program.

Inclusion Criteria

A protocol was used for establishment of the inclusion and exclusion criteria. Full-text articles in English language were assessed for the following inclusion criteria including:

(1) Patients who had class IV cavities
(2) The technique was direct composite
(3) 3) Evaluate (C) in Direct clinical evaluation criteria (modified USPHS criteria)(Table 3) or (3) World Dental Federation (FDI) criteria (Table 4) as a failure
(4) The follow-up time was documented. Studies were excluded if they were animal or *in vitro* studies. Duplicate publications (risk of bias), articles without diagnosis information were removed from the study.

Evaluation of papers and level of evidence

In an initial search, 47 articles were identified through electronic database. After removing duplications 28 articles were evaluated. Five articles were choose (Table 3). The total subject (Failed Class IV Direct Composite Restorations) number was 89 (Table 3). The medium follow up time was between two to twenty years. Restored with 8 different composite materials (Table 2).

Table 1. Issues of interest based on study population, intervention, control group and outcome measures (PICO).

Parameters for eligible studies
P Patients who had class IV cavity
I Direct composite restoration
C Resin Composite: Nanofilled resin composite (Filtek Supream), Nano hybrid (Ceram X Duo), polyacid-modified resin composite (compomer), resin-modified glass ionomer cement , universal composites (Charisma), universal composites (Herculite XR) , Highly Filled Hybrid Composite (TPH) , microhybrid composite, Amaris (Voco) and non specific resin composite
O Failuer reason
P, population; I, intervention; C, control; O, outcome

Table 2. Material and Manufacturer of composite resin in this study.

Composite	Manufacturer
Nanofilled resin composite (FiltekSupream)	3M ESPE
Nano hybrid (Ceram X Duo)	DentsplyDeTrey, Konstanz
polyacidmodified resin composite (compomer)	----------
resin-modified glass ionomer cement	----------
universal composites (Herculite XR)	HeraeusKul- zer, Hanau, Germany
universal composites (Charisma)	Kerr, Orange, CA, USA
Highly Filled Hybrid Composite (TPH)	Dentsply
microhybrid composite	Amaris, Voco

Table 3. Direct clinical evaluation criteria (modified USPHS criteria).

Category	Evalution Scale		Criterion
	Accebtabe/Unaccebtable		
Marginal adaptation	A B	 C	Undetectable by exploration Detectable gap (Exploratory probe sticks in both pathways) Obvious gap or fracture.
Anatomic shape	A B	 C	Undetectable gap Detectable gap in enamel only Detectable gap involving enamel-dentin
Marginal discoloration	A B	 C	Without discoloration superficial stain (removable, usually localized) Deep stain
Caries formation	A	 B	Without evidence of caries Evidence of caries
Post-operative sensitivity	A	 B	Absence of post-operative Post-operative sensitivity experienced at some time during restorative process, or study period.
Retention	A B	 C	Retained Partial Retained Loss Restoration

Table 4. FDI Criteria.

	Esthetic property	Functional properties		Biological properties	
	1. Marginalstaining	**2. Fractures andretention**	**3. Marginaladaptation**	**4. Postoperative(hyper) sensitivity**	**5. Recurrence ofcaries**
1. Clinically very good	1.1 No marginal staining.	2.1 Restoration retained, no-fractures/cracks.	3.1 Harmonious outline, no gaps, no discoloration	4.1 No hypersensitivity	5.1 No secondary or primary caries
2. Clinically good	1.2 Minor marginal staining, easily removable by polishing	2.2 Small hairline crack.	3.2.1 Marginal gap (50 mm).3.2.2 Small marginal fracture removable by polishing	4.2 Low hypersensitivity for a limited period of time.	5.2 Very small and localized demineralization. No operative treatment required
3. Clinically sufficient/ satisfactory(minor short comings with no adverse effects, but not adjustable without damage to the tooth)	1.3 Moderate marginal staining, not esthetically unacceptable	2.3 Two or more orlarger-hairline cracks and/or chipping (not affecting the marginal integrity)	3.3.1 Gap <150 mmnot removable. 3.3.2 Several small enamel or dentinfractures.	4.3.1 Premature/slightly more intense. 4.3.2 Delayed/weaksensitivity, no subjective complaints, no treatment needed	5.3 Larger areas of demineralization, but only preventive measures necessary (dentin not exposed
4. Clinically unsatisfactory (repair for prophylactic reasons)	1.4 Pronounced marginal staining; major intervention necessary for improvement.	2.4 Chipping fractures that damage marginal quality; bulk fractures with or without partial loss (less than half of the restoration).	3.4.1 Gap >250 mmor dentin/base exposed. 3.4.2 Chip fracture damaging margins. 3.4.3 Notable enamel or dentin wall fracture	4.4.1 Premature/very intense. 4.4.2 Extremely delayed/weak with subjective complaints. 4.4.3 Negative sensitivity intervention necessary but not replacement.	5.4 Caries with cavitation (localized and accessible and can be repaired).
5. Clinically poor (replacement necessary)	1.5 Deep marginal staining not accessible for intervention	2.5 Partial or complete loss of restoration.	3.5 Filling is loose but in situ	4.5 Very intense, acute pulpitis or nonvital. Endodontic treatment is necessary and restoration has to be replaced	5.5 Very intense, acute pulpitis ornonvital. Endodontic treatment is necessary and restoration has to be replaced

The number of subjects who restored with Nanofilled resin composite (FiltekSupream) was 12, 13 subjects restored with Nano hybrid (Ceram X Duo), 13 subjects restored with poly acid modified resin composite (compomer), 7 subjects restored with resin-modified glass ionomer cement, 8 subjects restored with universal composites (Herculite XR), 16 subjects restored with universal composites (Charisma), 7 subjects restored with Highly Filled Hybrid Composite (TPH), 11 subjects restored with non specific resin composite and 2 subjects restored with microhybrid composite, Amaris (Voco).

In 12 subjects who restored with Nano filled resin composite (FiltekSupream), the failure reason in 9 subjects was lack of retention and in 3 subjects was restorations fracture in follow up time between 2 to 5 years. In 13 subjects who restored with Nano hybrid (Ceram X Duo), the failure reason in 10 subjects was lack of retention and in 3 subjects was restorations fracture in follow up time between 2 to 5 years. In 13 subjects who restored with polyacidmodified resin composite (compomer), the failure reason in all subjects was restorations fracture in follow up time 7 years and 6 months. In 7 subjects who restored with resin-modified glass ionomer cement, , the failure reason in all subjects was restorations fracture in follow up time 7 years. In 8 subjects who restored with universal composites (Herculite XR), the failure reason in 2 subjects was esthetic reason, in 2 subjects was restorations fracture, in 4 subjects was anatomic form change in follow up time between 10 to 20 years. In 16 subjects who restored with universal composites (Charisma), the failure reason in 9 subjects was esthetic reason, in 3 subjects was restorations fracture, in 2 subjects was marginal breakdown and in 2 subjects was anatomic form change in follow up time between 0 years to 20 years. In 7 subjects who restored with Highly Filled Hybrid Composite (TPH), the failure reason in 6 subjects was lack of retention and in 1 subject was restorations fracture, in follow up time 3 years. In 2 subjects who restored with microhybrid composite, Amaris (Voco), the failure reason in all subjects was lack of retention in follow up time 2 years. In 11 subjects who restored with non specific resin composite, the failure reason in all subjects was fracture restorations in follow up time 10 years.

Discussion

The longevity of composite restorations has been a topic of discussion for many years. There are Many variables affect longevity of composite restorations, including type of dentition, location and size of restoration, reasons for placement, type of material, adhesion, etc. The main reasons for replacement of anterior composite restorations are typically surface discoloration, secondary caries, and/or fracture of the restoration [5].

The reasons of failure can be loss of restoration for lack of retention, fracture of the restoration, esthetic reason (dis), restoration anatomical form change or restoration marginal breakdown Direct clinical evaluation criteria (modified USPHS criteria) (Table 4).

Class IV restorations had higher failure rates than Class III or V restorations. Longevity of large Class IV composite restorations placed in fractured anterior teeth has been shown to be relatively short. This is attributed to the relatively great amount of stress applied to these restorations during occlusal function [5].

This study show reasons of failure of direct class IV composite restoration in some composite materials and the longevity of these materials. Hybrid composites as traditional hybrids, micro-, and nanohybrids. Contain of submicron inorganic filler particles (0.04 mm) and small particles (1 mm-4 mm), to improve the physical properties as well as acceptable levels of polishability. These improvements in wear resistance and fracture strength, along

Table 5. (Demirci 2018) [6].

N of Restorations	Criteria	Composite Type	N/R of Failed Restorations	Follow Up Year	Adhesive Material	Failure
42	modified USPHS criteria	Nanofilled resin composite (FiltekSupream)	12(28%)	2-5	(XP Bond) and three-step (Scotch- bond Multipurpose) e	Lack of Retention and Fractured Restoration
42	modified USPHS criteria	Nano hybrid (Ceram X Duo)	13(30%)	2-5	(XP Bond) and three-step (Scotch- bond Multipurpose) e	Lack of Retention and Fractured Restoration

Table 6. van Dijken 2010 [7].

N of Restorations	Criteria	Composite Type	N/R of Failed Restorations	Follow Up Year	Failure
43	modified USPHS criteria	Resin Composite Non-Specific	11(25%)	10	Fractured Restoration
24	modified USPHS criteria	polyacid-modified resin composite (compomer)	13(54%)	7.5	Fractured Restoration
18	modified USPHS criteria	resin-modified glass ionomer cement	7(39%)	7	Fractured Restoration

Table 7. Baldissera 2013 [8].

N of Restorations	Criteria	Composite Type	N/R of Failed Restorations	Follow Up Year	Adhesive Material	Failure
51 total Class IV	FDI criteria	universal composites (Herculite	8 (Class IV and III) the author didn't separate	10-20	Scotch Bond Multi-Purpose Single Bond (3M ESPE	Esthetic Reasons, Fractured Restoration and Anatomic Form Change
51 total Class IV	FDI criteria	universal composites (Charisma)	16(Class IV and III) the author didn't separate	0-20	Scotch Bond Multi-Purpose Single Bond (3M ESPE	Esthetic Reasons, Fractured Restoration, Anatomic Form Change and Marginal Breakdown

Table 8. Renato 2011 [9].

N of Restorations	Criteria	Composite Type	N/R of Failed Restorations	Follow Up Year	Adhesive Material	Failure
36	modified USPHS criteria	Highly Filled Hybrid Composite (TPH)	7(19%)	3	Prime & Bond; DentsplyInd	Lack of Retention and Fractured Restoration

Table 9. Barcellos 2013 [6].

N of Restorations	Criteria	Composite Type	N/R of Failed Restorations	Follow Up Year	Adhesive Material	Failure
32	criteria introduced by Vanherle and others	microhybrid composite, Amaris (Voco)	2(6%) with Adper Single Bond 2 (3M ESPE, St Paul, MN, USA)	2	Adper Single Bond 2 (3M ESPE, Futura bond M (Voco), Opti- bond All-in-One (Kerr Corporation and Clearfil S3 Bond	Lack of Retention

with good polishability, make hybrids the material of choice for Class III and Class IV restorations, 1, Nanofilled resin composite (FiltekSupream) and Nano hybrid (Ceram X Duo) both have the same longevity between two to five years in direct class IV composite, loss of restorations for lack of retentionand fracture of restorations is the main reason of failure for both.

Universal composites (Herculite XR) the most reason of failure in this type of composite is the anatomic form change, in the other hand, universal composites (Charisma) the esthetic reasons are the main reasons of failure. Both of them have long longevity until fifteen years.

Polyacid modified resin composite (compomer) and resin-modified glass ionomer cement have the same reason of failure that is restorations fracture in seven year more or less.

Highly Filled Hybrid Composite (TPH) and microhybrid composite, Amaris (Voco) loss of restoration for lack of retention is the main reason of failure for both. However, they have short longevity between two to three years.

One of the factors that could greatly influence the longevity of direct composite resin restorations is the strength and long-term reliability of the adhesion to the tooth structure [10].

Regarding to the data that we collected in this study, of 89 failed direct class IV composite restoration, in follow up time between 2 to 20 years, by using 8 different types of composite. Fracture of the restorations is the most reason of failure with 43(48.3%) failed restorations, then loss of restorations for lack of retention with 27(30.3%) failed restorations, then then failure for esthetic reasons with 11(12.3%) failed restorations, then failure for change in the anatomical form of restorations with 6(6.7%) failed restorations and the less reason of failure is restoration marginal breakdown with 2(2.2%) failed restorations.

Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

Conclusion

Three things decide the success rate, the survival rates and the longevity of direct class IV composite restorations, the dentist, the material andthe patient. The study show failure reasons for different composite risen materials and the longevity. Fracture of restorations and loss of restorations for lack of retention are the most failure reasons. Patients must be educated about the expected life of these restorations as well as their advantages and disadvantages, so they can make an informed decision on a treat-

ment option. There is lack of information about the longevity, survivalrates, failure reasons of class IV direct composite in last 10 years. This study evaluate the reason of failure regarding to the studies that we showed.

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