ORIGINAL ARTICLE

Composite resin in the last 10 years – literature review. Part 6: longevity

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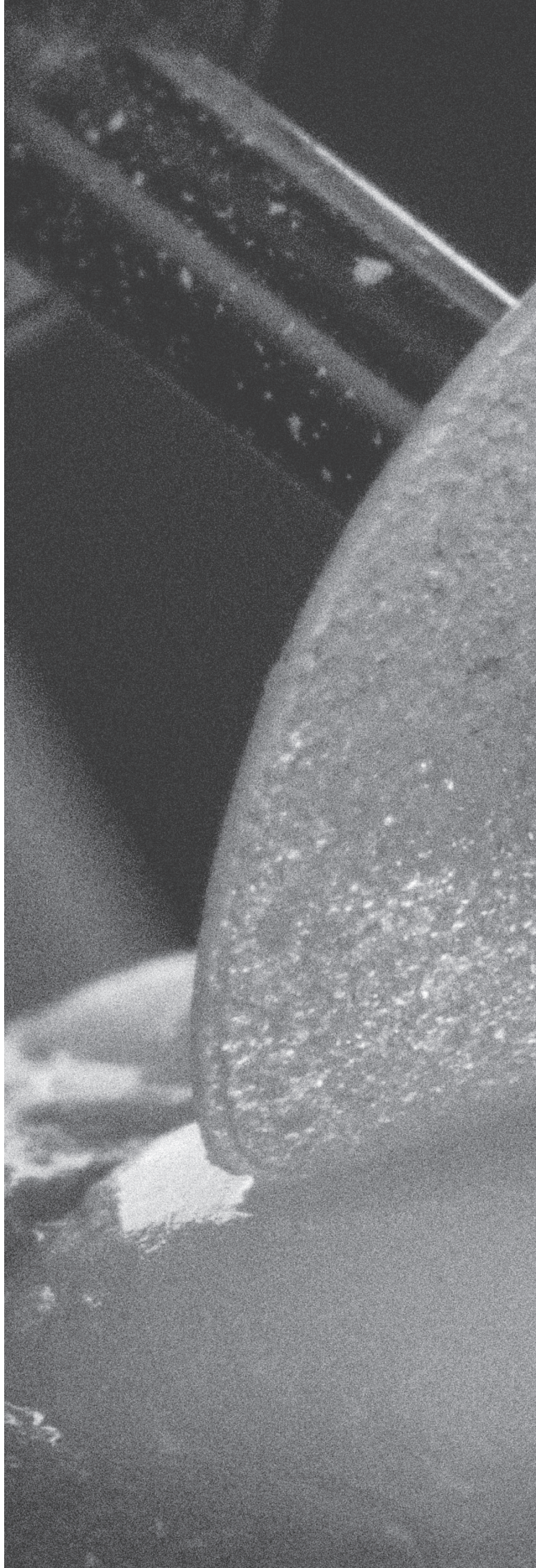

ABSTRACT: Introduction: This is the last article of a series of six manuscripts about composite resins in the last 10 years. The composite resin is widely used in clinical dental practice and the knowledge of it behavior in long-term is necessary. Thus, the aim of this literature review is evaluate clinical longevity and failure rate of composite resins restorations. **Methods:** A broad search was performed in the PubMed/Medline database between 2007 and 2018. After title and abstract evaluation, 65 articles were select for full reading and 30 were included in this literature review. Data were extracted and the results interpreted. **Results:** The evaluation time ranged between 1 and 22 years and the failure rate between 0 and 54.8. The main reasons of failure were secondary caries, marginal discoloration and restoration/tooth fracture. **Conclusions:** The composite resin presents good longevity regardless of the type of material used. However, the studies that analyzed less than 5 years are considered inconclusive. **Keywords:** Composite resin. Longevity. Composites.

INTRODUCTION

The composite resin is a direct restorative material used in dentistry for over 50 years. The main reasons for the wide application of this material are biocompatibility, reversibility, color stability, in addition to the possibility of being used in the anterior and posterior regions of the oral cavity.[1,3] With the advancement of research and the development of new technologies in recent years, composite resins have become increasingly aesthetic and have better mechanical and optical properties.[4-5]

When it comes to the evolution of compounds, the 50's deserves to be highlighted. In 1955, Buonocore presented an enamel acid etching technique, favoring adhesion to the dental structure.[6] In the following years, the introduction of Bis-GMA and the development of techniques for etching the dental structure, made it possible to improve the properties of composite resins and their ability to adhere to the dental structure, enabling an increase in their indication spectrum. Associated with this fact, it is noteworthy that, at the same time, there was a decline in the manufacture of amalgam restorations, due to darkened coloring, considered non-aesthetic, which further favored the use of composite resins.[7]

Although the evolution of composite resins, there are still some factors that provide a reduction in the longevity of restorations made with this material. Secondary caries or caries adjacent to the restoration is one of the main factors responsible for this decrease, mainly due to the unsatisfactory etching of the dental structure, which can favor bacterial colonization at the tooth-restoration interface.[8,9] Another factor related with the failure of composite resin restorations is the light curing unit used, because to achieve satisfactory mechanical and aesthetic properties, an adequate and effective photoactivation is required.[10] The degree of conversion, which represents the amount of monomers that are converted into polymers, is influenced by the irradiance of the light curing unit and can be responsible for these failures. So the lower the degree of conversion value, the greater the chance of the restoration failing.[11]

In this context, this literature review is the last part of the set of 6 articles, addressing different clinical, scientific and biomechanical aspects that impacted composite resins in the last 10 years. Thus, the aim of this study was to raise and synthesize the data of longevity and failure rates of composite resin restorations available in the literature.

METHODS AND MATERIALS

The literature review was perfomed based on a wide bibliographic search carried out in the database Medline/PubMed, using the combination of the terms "Composite Resins", "Clinical Trial", "Intervention Study" and "Controlled Clinical Trial". Only clinical studies, published in English, between 2007 and 2018 were included in this review. After the initial search and reading of titles and abstracts, 65 articles were selected. Subsequently and after evaluating the full texts, 30 articles were effectively examined and included in this literature review. The data were then extracted and organized in a table, in order to present the longevity results obtained in each study.

RESULTS

Table 1 describes the characteristic of the 30 included articles: study design, time of follow-up, number of restoration, number of teeth, materials used, failure rate and reasons of failure. The studies were prospectives (20) and retrospectives (10) with follow-up time of 1 to 22 years. Most articles (23) evaluated posterior teeth restorations (molars and/or premolars). In relation to the restorative material, 24 studies compared different composite resins and 4 compared amalgam with composite resins. The final failure rate of composite resin versus amalgam are described in Figure 1. The studies of Bernardo et al.[12] and Opdam et al.[19] presented statistical difference between the materials (amalgam and composite). The composite Tetric Ceram (Ivoclar Vivadent) was the most evaluated material. The failure rate of composite resins were between 0 and 54.8%. The main criteria used to evaluate the failure rate of composite restorations was the USPHS criteria. The studies with short time of follow-up (1 to 3 years) presented the lowest values of failure rate. The main cause of restoration failure were secondary caries, marginal discoloration and fracture of restoration/tooth.

Table 1: Characteristics of available studies.

YEAR	AUTHOR	STUDY DESIGN	FOLLOW-UP (YEARS)	NUMBER OF RESTORATIONS	NUMBER OF TEETH
2007	Bernardo et al.[12]	Retrospective	7	1748	203 PM and 1545 M
2007	Opdam et al.[13]	Retrospective	10	2867 class I and II	1043 PM and 1824 M
2009	Kiremitci et al.[15]	Prospective	6	47 class II	27 PM and 20 M
2009	Manhart et al.[16]	Prospective	4	96 class I and II	96 M
2010	Kubo et al.[17]	Prospective	3	98 restorations of non-carious cervical lesions	48 PM 12 M; 18 C and 20 I
2010	Van Dijiken[18]	Prospective	12	90 class I	23 PM and 67 M
2010	Opdam et al.[19]	Retrospective	12	1949 class II	AM: 389 PM and 813 M. RC: 243 PM and 513M
2010	Shi et al.[20]	Prospective	3	100 class I	6 PM and 94 M
2010	Arhun et al.[21]	Prospective	2	82 class I and II	42 PM and 40 M
2011	Kramer et al.[14]	Prospective	6	68 class II	45 PM and 23 M
2011	Da Rosa et al.[22]	Retrospective	22	362 class I and II	168 PM and 194 M
2011	Burke et al.[23]	Retrospective	2	100 class I and II	27 PM and 73 M
2011	Andrade et al.[24]	Prospective	2,5	123 class I	123 M

MATERIALS	SURVIVAL RATE	REASONS OF FAILURE	CONCLUSIONS
AM and RC: Z100 MP +Scotchbond Multi-Purpose (3M ESPE)	AM: 5,6% RC:14,5%.	Secondary caries	Amalgam restorations performed better than composite resin restorations
AM and RC: Clearfil Photo Posterior (Kuraray), APH (Dentsply), Superlux Molar (DMG), P50 (3M ESPE), Clearfil AP-X (Kuraray), Charisma (Heraeus Kulzer), Z100 (3M ESPE), Tetric (Ivoclar Vivadent), Prodigy (Kerr), Pertac Hybrid (ESPE)	AM:20% RC:17,8%	Secondary caries, endodontic treatment and tooth fracture	The materials had similar survival rate
Filtek P60 (3M ESPE)	4,2%	Change of restorations due to the appearance of new caries not associated with restoration	The material showed excellent performance.
QuiXfill (Dentsply) and Tetric Ceram (Ivoclar Vivadent)	QuiXfill: 6,5% Tetric: 2%	Tooth fracture, restoration fracture and postoperative sensitivity	Both materials showed good results and presented no statistical difference
Clearfil AP-X (Kuraray) and Clearfil Flow FX (Kuraray)	AP-X: 4,1% Flow FX: 6%	Secondary caries; polymerization contraction; occlusal trauma and thermal changes	Both types of composite performed acceptable clinical performance
Dyract (Dentsply) and Prisma TPH (Dentsply)	Dyract: 2,4% Prisma: 2,4%	Secondary caries	The techniques used resulted in excellent durability for restorations
AM and RC: Clearfil PhotoPosterior (Kuraray) and AP-X (Kuraray).	AM: 24,3% RC: 15,2%.	Secondary caries and fractures	Composite resin restorations showed better survival rate than amalgam
Synergy Compact (Coltene) and TPH Spectrum (Dentsply)	Synergy: 5% TPH Spectrum: 10%	Fractures or loss of restoration	Both composites had satisfactory results
Grandio (Voco) and Quixfil (Denstply)	Grandio: 0% Quixfil: 5%	Secondary caries	Both composites had satisfactory results
Grandio (Voco) and Tetric Ceram (Ivoclar Vivadent)	0% for the two groups	Only had repairable defects related to marginal integrity	There was no significant differences in the performance of the resins presented
P-50 APC (3M ESPE) and Herculite XR (Kerr)	P-50: 26% Herculite: 36%	Fractures	P-50 had better results than Herculite
Filtek Silorane (3M ESPE)	0%	Modification of the anatomical shape; marginal mismatch and marginal discoloration repairable	The material had satisfactory results
Filtek Z350 (3M ESPE); Esthet-X (Dentsply) and como controle Filtek Z250 (3M ESPE)	Filtek Z350: 5,4% Esthet-X: 8,1% Filtek Z250: 5,4%	Anatomical shape, discoloration and marginal mismatch	The investigated materials showed acceptable clinical performance

Table 1: **(continuation)** Characteristics of available studies.

YEAR	AUTHOR	STUDY DESIGN	FOLLOW-UP (YEARS)	NUMBER OF RESTORATIONS	NUMBER OF TEETH
2012	Gresnigt et al.[25]	Prospective	4	96 veneers	40 IC, 38 IL and 18 C
2013	Pallesen et al.[26]	Prospective	8	4355 class I	848 PM and 3507 M
2013	Kim et al.[27]	Retrospective	5	967 class I, II, II, IV and V	676 composite resin, 144 glass ionomer and 147 amalgam
2013	Van Dijiken et al.[28]	Prospective	6	122 class II	49 PM and 73 M
2013	Al-Khayatt et al.[29]	Prospective	7	145 restorations for vertical dimention (VD) increase	89 em dentes anteriores inferiores e 56 em superiores
2013	Efes et al.[30]	Prospective	3	100 class I	100 M
2014	Beck et al.[31]	Prospective	1	1805 class I or II	726 PM and 1079 M
2014	Van Dijiken et al.[32]	Prospective	3	104 class I and II	47 PM and 57 M
2015	Lempel et al.[33]	Retrospective	10	701 class II	359 PM and 242 M
2015	Kurokawa et al.[34]	Prospective	3	53 class I and II	11 class I and 42 class II in M and PM
2016	Naghipur et al.[36]	Retrospective	12	2820 class II	1695 in RC and 1125 in AM, in PM
2017	Estay et al.[37]	Prospective	12	174 class I and II	46 RC and 126 AM
2017	Van Dijiken[38]	Prospective	6	139 class II	46 PM and 93 M
2018	Burke et al.[39]	Retrospective	15	3,5 million restorations of all types	All
2018	Heck et al.[40]	Retrospective	10	96 class I and II	First and second molars

AM: amalgam/ CR: composite resin /Ad: adhesive / GI: glass ionomer/ PM: premolars / M: molars / C: canines/ I: incisors/ CI: central incisors/ LI : lateral incisors / FR: Failure R

MATERIALS	SURVIVAL RATE	REASONS OF FAILURE	CONCLUSIONS
Ena-Bond-Enamel HFO (Micerium) and Clearfil SE Bond-Miris2 (Coltene)	Enamel HFO: 23% Miris2: 6,2%	Surface roughness and discoloration	The composites showed similar clinical performance
Herculite (Kerr) and Spectrum (Dentsply)	TxF cumulative: 15,7%	Secondary caries, postoperative sensitivity and fracture of the restoration	The longevity of restorations was good when compared to other clinical studies
-	AM: 27,8% RC: 29,1% IN: 43,2%	Secondary caries, marginal adaptation and discoloration	The composite resins showed better longevity to the other materials
Tetric EvoCeram (Ivoclar Vivadent) and Tetric Ceram (Ivoclar Vivadent)	Evo Ceram: 13,6% Ceram: 10,2%	Secondary caries	Tetric Ceram showed better clinical performance compared to Tetric Evo Ceram
Herculite XRV (Kerr)	15%	Marginal discolaration	Restorations bonded to their worn anterior mandibular dentition are predictable and relatively durable
Filtek Silorane (3M ESPE) and Ceram X Duo (Dentsply)	Filtek: 8% Ceram: 14%	Marginal adaptation and surface texture	Both materials showed good clinical performance
Ceram X (Dentsply) / Prime & Bond NT(Dentsply) and Tetric Ceram (Ivoclar Vivadent) / Optibond Solo Plus (Kerr)	Ceram X: 5,3% Tetric Ceram: 6,1%	Marginal adaptation and fill integrity	There was no significant difference between the composites
Ceram X (Dentsply) and SDR (Dentsply)	Ceram X: 1,3% SDR: 0%	Secondary caries and postoperative sensivity	The composite resin (SDR) showed better results than nanohybrid (Ceram X)
Filtek Z250 (3M ESPE), Herculite XR (Kerr), Gradia Direto Posterior (GC), Renew (Bisco)	TxF cumulative: 2,1% Filtek: 0,9% Herculite: 1,36% Gradia: 8,75% and Renew: 7,81%	Fracture of the restoration; secondary caries and endodontic treatment	Higher failure rates were observed in Renew and Grandia Direct Posterior composites
Beautifil II (Shofu) (3M ESPE) and P90 (3M ESPE)	9,7-54,8%	Surface roughness, marginal adaptation, and discoloration	The material showed good results
RC and AM	AM: 5,9% RC: 7,9%	Secondary caries and teeth fracture	Both materials had acceptable success rates.
RC and AM	AM: 11,1% RC: 6,5%	Marginal adaptation and secondary caries	No difference was found in the longevity of restorations
RC: els (Saremco AG); Ad: cmf (Saremco) and AdheSE One F (Vivadent Ivoclar)	Adesivo cmf: 11.4% AdheSE One F: 20%	Secondary caries	Restorations made of both materials had good durability
The brand of the material was not identified because it is a study based on analysis of medical records	About 17% of teeth restored with composite resin were extracted after 15 years	According to cavity size and restorative technique	Factors that influence survival are the patient's age, the dentist's age / experience and the patient's need for treatment
QuiXfil (Denstsply) and Tetric Ceram (Ivoclar Vivadent	QuiXfil: 23,1% Tetric Ceram: 13,3%	Secondary caries; teeth fracture and postoperative sensitivity	Both materials had aceptables results

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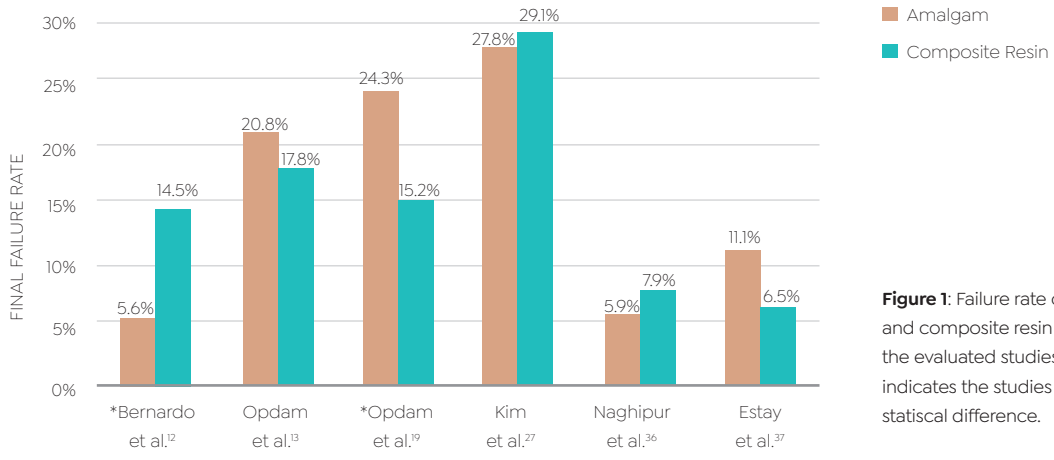

Figure 1: Failure rate of amalgam and composite resin restorations in the evaluated studies. The asterisk indicates the studies results with statiscal difference.

DISCUSSION

The longevity of composite resin restorations is influenced by many factors, which are related with the operator and the technique used, as well with oral hygiene and patient habits.[41] The main reasons of failure found in this literature review were fracture of restoration/tooth, marginal discoloration and secondary caries. The fracture of restoration can be associated with the occlusion contacts and parafunctional habits, such as bruxism and clenching. The margin discoloration is related with failures in the adhesive interface, polymerization shrinkage and pigmentation of the restoration.[42] The presence of secondary caries can be associated with the patient's oral hygiene and with failures in the restorative procedures that causes problems in the marginal adaptation.[41]

The failure rate of the studies evaluated in this literature review were between 0 and 54.8%. To explain this wide variation in the results, it is necessary to analyze the methodology and the time of follow-up of the compared studies. Although the USPHS (US Public Health Service) criteria was the most used, many studies performed the re-

searches using modified criteria or showed short time of follow-up. The study of Kurowaka et al.[34] presented the greater failure rate (54.8%) because of the evolution criteria used, which classified surface roughness alterations as failure of the restoration. Other studies classified these same alterations as possible of repairing or polishing. In the other hand, the studies with 0% of failure rate evaluated the restorations for a short period (between 1 and 2 years).[23,35] In a short follow-up, it is common the studies present lower failure rate, because the main alterations usually appear after 5 years.[19] Thus, studies with evaluation over longer periods represent results more consistent with the clinical reality.

Some studies compared the longevity of composite and amalgam restorations.[12,13,19,27,36,37] The amalgam restorations were part of the clinical routine for many years, however, currently it have been replaced by composite resin restorations mainly due to the aesthetic characteristics.[7] Although the different results found in this review, most articles presented no difference in the longevity of composite and amalgam restorations. The diversity of materials and techniques used in restorative procedures can influence the longevity of restorations, which explain the divergent results found in the evaluated studies. The influence of composition and mechanical properties in the quality of composite restorations is discuss in the parts 1 and 2 of this literature review, respectively.

In this context, when the dentist faced a composite resin restoration failure, one of the most important aspects to consider is the restoration appearance, in order to establish which procedure should be performed. Then, it will be possible to determine the presence of reparable failures (unsatisfactory polishing and presence of surface roughness) or not reparable (loss of restoration anatomy and shape).[37,43]

This study was not a systemic review, so it presents some limitations, such as the lack of standardization in the analysis criteria of the restorations and the variation in the follow-up time, which made difficult to precisely compare the studies. Thus, more standardized studies are needed to make it possible the comparison of the results. In addition, this review was performed with studies from the last 10 years in the English language, which suggests that future investigations, involving more clinical studies, should be conduced in order to verify the data obtained.

The longevity of composite restorations should interest researchers and clinicians. In the clinical

practice, it is necessary to know the main reasons of failure and the average time of the survival rate for restorative materials. However, it is also important to understand all factors that can influence the longevity of these restorations. Therefore, it is important to consider the composition and the mechanical properties of the restorative material to each clinical situation (part 1 and 2), in addition to carefully observe the photoactivation conditions (part 3) and the techniques and materials used (shrinkage stress, part 4). The patient must also be oriented for oral hygiene and habits, in order to reduce the color alterations and the deterioration of the material (part 5). With all these factors, it is possible to guarantee predictable and satisfactory longevity of composite restorations.

CONCLUSIONS

Within the limitations of this study, it can be concluded that the composite resin is a restorative material that has satisfactory longevity, presenting failure rate between 0 and 54.8%, according to the characteristics of each study.

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