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## Učinak kvalitete zubnih ispuna i vremena proteklog od izrade na zadržavanje biofilma

### *Effect of Quality of Dental Restorations and Time Elapsed Since Placement on Biofilm Retention*

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#### Sažetak

**Svrha:** U istraživanju se željela procijeniti povezanost zadržavanja biofilma i vremena proteklog otkako je postavljen na smolom restaurirane površine prednjih zuba. **Metode:** Uzorak se sastojao od 120 zuba 40 pacijenata obaju spolova u dobi između 16 i 60 godina. Ukupno je na njima bilo 230 restauriranih površina. Za mjerenje stupnja zadržavanja biofilma i površinske hrapavosti materijala te vrste kaviteta i rubova bili su potrebni indeks zadržavanja plaka i opseg restauracija (PRRI), a procjenjivala su se i vanjska svojstva preparacije kaviteta. **Rezultati:** Gotovo sve proučavane površine bile su postavljene prije jedne do pet godina. Najčešći PRRI za zadržavanje biofilma je bio II i IV, 83 posto uzoraka imalo je grubu površinu, a 46,5 posto kavitete II. razreda. Subgingivno je bilo 62,2 posto rubova, a kod 38,6 posto zabilježen je višak korištenog restaurativnog materijala. Površinska hrapavost restauracije bila je usko povezana sa zadržavanjem biofilma i vremenom postavljanja (oba  $p < 0,01$ ). Vanjska svojstva restauracije (prekonturiranje, manjak materijala za restauraciju, spoj zub – restauracija) također su značajno bili povezani s vremenom proteklom od postavljanja (svi  $p < 0,05$ ). **Zaključak:** Vrijeme proteklo od postavljanja smolaste restauracije utječe na hrapavost površine i stupanj zadržavanja biofilma.

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#### Ključne riječi

preparacija kaviteta; kompozitne smole, svojstva površina, biofilm

#### Uvod

Posljednjih godina sve su češće estetske restauracije u prednjim i stražnjim područjima usne šupljine (1). Pritom materijali moraju oponašati boju, teksturu i translucenciju (optičku prozirnost) prirodnog zuba. Trebaju također biti čvrsti i imati sposobnost brtvljenja (2). No takve restauracije katkad ne uspiju zbog mnogo razloga – sekundarnog karijesa, pretjeranog trošenja, popuštanja rubova, osjetljivosti zuba, odumrle pulpe i pucanja restaurativnog materijala (3). Jedan od razloga za kliničku *dugovječnost* bilo koje restauracije jest otpornost na trošenje u oralnom okolišu (4). Istraživanja *in vitro* (5, 6) i *in vivo* (7, 8) pokazala su da se plak češće zadržava na restauracijama od smolastih kompozita negoli na ostalim restaurativnim materijalima ili tvrdim zubnim tkivima poput cakline (9 – 11). Za loše kompozitne restauracije obično je kriv razvoj karijesne lezije i pojačano nakupljanje naslaga uz rubove, a to smanjuje njezinu trajnost (3). Odgovor gingivnog tkiva na restaurativne postupke povezan je s rubovima restauracija i oblikom, prevjesima i hrapavošću površine te vrstom uporabljenog materijala (12 – 16). U nekim istraživanjima istaknuto je da površine restaurirane smolastim materijalima mogu zbog pojačanog nakupljanja plaka utjecati na parodontni status (1). Čini se da vrsta kompo-

#### Introduction

The demand for aesthetic restorations in the anterior and posterior regions of the oral cavity has increased in recent years (1). Aesthetic restorative materials must simulate the colour, texture, and translucency of the natural tooth and should have adequate strength, wear, and sealing characteristics (2). These restorations can fail for various reasons, such as secondary caries, excessive wear, marginal degradation, tooth sensitivity, pulpal death, and restorative material fracture (3).

One factor determining the clinical longevity of any restorative material is its wear resistance in the oral environment (4). *In vitro* (5, 6), and *in vivo* (7, 8) studies have reported more plaque accumulation on resin composites than on other restorative materials or dental hard tissues, such as enamel (9-11). Composite restoration failure is usually attributed to the development of an adjacent carious lesion and can be explained by the enhancement of plaque accumulation adjacent to restoration margins, which decreases restoration longevity (3).

The response of gingival tissues to restorative procedures has been related to restorative margin location and contour, the presence of overhangs and surface roughness, and the

zitrne smole (konvencionalna, hibridna ili s mikropunilom) nema klinički utjecaj na parodontne rubove, a starost restauracija od kompozitne smole može negativno djelovati na zdravlje desni (17, 18).

Kako bi se onemogućio karijes i povećala trajnost restauracije, kompozitnim materijalima pokušavala su se dodavati antibakterijska sredstva (2). Tako se postupno otpuštanje antibiotika i biocida koji se dodaju u zubne kompozite mogu iskoristiti za inhibiciju ili uništavanje plaka koji pridonosi razvoju karijesa i degradira kompozit (9).

Svrha ovog istraživanja bila je procijeniti povezanost zadržavanja biofilma na površinama prednjih zuba restauriranih kompozitnim materijalom i vrijeme proteklo od postavljanja s kvalitetom restauracije, uključujući hrapavost restaurirane površine, vrstu kaviteta i rubova te vanjska svojstva ispuna.

## Materijali i metode

U ovom istraživanju sudjelovalo je 40 pacijenata i pacijentica u dobi od 16 do 60 godina koji su se liječili u ordinacijama Stomatološkog fakulteta Sveučilišta Pernambuco u Brazilu. Istraživanje je odobrilo fakultetsko Etičko povjerenstvo (broj 0305/10).

Među kriterijima za odabir bile su površine restaurirane kompozitnim materijalom na prednjim zubima i dobrovoljni pristanak pacijenata. Iz istraživanja su odmah isključeni pojedinci sa sistemskim bolestima, loše raspoređenim zubima, i/ili površinama restauriranim rekurentnim ili sekundarnim karijesom, te korisnici ortodontskih naprava ili tekućina za ispiranje usta, pušači ili bivši pušači, osobe koje dišu na usta te one koje su si izbjeljivale ili izbjeljuju zube. Vrsta kaviteta (od III do V) određivala se kliničkim pregledom, kao i smještaj rubova preparacije (supragingivne, u razini gingive, subgingivne) i vanjski izgled restauracije poput aproksimalnog kontakta, rekonturiranja ili potkonturiranja, viška ili manjka restaurativnog materijala te međuspoj zuba i restauracije. Hrapavost površine procjenjivala se taktilno sondom. Vrijeme proteklo od postavljanja ispuna određivalo se prema datumu u zubnim kartonima pacijenata i svrstano je bilo u tri skupine – od jednoga do jedanaest mjeseci, od jedne do pet godina i više od pet godina. Stupanj zadržavanja biofilma na

type of restorative material (12-16). Some studies have also reported that resin-restored surfaces may affect periodontal status through the enhancement of plaque accumulation (1). The type of composite resin (conventional, hybrid, or microfiller) seems to have no clinical effect on the periodontal margin whereas the ageing of composite resin restorations may negatively interfere with gingival health (17, 18).

To prevent caries recurrence and improve restoration longevity, attempts have been made to add antibacterial agents to composite restorative materials (2). The slow release of antibiotics and biocides added to dental composites can be used to inhibit or kill dental plaque, which contributes to caries development and causes composite degradation (9).

The aim of this study was to evaluate the associations of biofilm retention in resin-restored surfaces of anterior teeth with the time elapsed since placement and the quality of dental restorations, including surface roughness of the restorative material, cavity type and margins, and external cavity preparation characteristics.

## Material and methods

The present study was conducted on 40 patients of both sexes, aged 16–60 years, who were treated at the University of Pernambuco School of Dentistry, Brazil. The study was approved by the Ethics in Research Committee of the University of Pernambuco (No. 0305/10).

Inclusion criteria were the presence of a resin-restored surface in the anterior dentition and voluntary agreement to participate. Participants with systemic diseases, malpositioned teeth, and/or restored surfaces with recurrent or secondary caries, as well as those who used an orthodontic appliance or mouth rinse and/or were smokers or ex-smokers, mouth breathers, or undergoing tooth whitening procedures were excluded.

Clinical examinations were performed to determine the type of cavity (classes III–V), preparation margins (supragingival, gingival, subgingival), and external cavity preparation characteristics, such as proximal contact, over- or under-contouring, excess or lack of restorative material, and the tooth–restoration interface. The surface roughness of resin restorations was evaluated by tactile inspection with an explorer. The time elapsed since placement was recorded using the placement date listed in the patients' medical records and classified as 1–11 months, 1–5 years, or >5 years.

**Tablica 1.** Indeks zadržavanja plaka i opsežnosti restauracije  
**Table 1** Plaque Retention and Extension in Restoration Index.

Grade • Stupanj	Stanje • Condition presented
0	Nema plaka na restauraciji • No presence of plaque on the restoration.
1	Mjestimični plak na restauraciji bez širenja na površine zuba • partial plaque retention on the restoration without extension to the tooth surface.
2	Plak na svim površinama restauracije bez širenja na površine zuba • Plaque retention on all of the restoration without extension to the tooth surface.
3	Plak na restauraciji i širenje na površine zuba • Plaque retention on the restoration, extending to the tooth surface.
4	Plak na restauraciji i širenje na površine zuba te prema području sulkusa • Plaque retention on the restoration, extending to the tooth surface and toward the sulcular region.

površinama restauriranim kompozitnom smolom određivao se vodenom otopinom 2-postotnog bazičnog fuksina. Za svaku površinu zabilježen je indeks opsega zadržavanja plaka (PRRI) (19) (tablica 1.).

Analiza je obavljena deskriptivnom statističkom metodom (aritmetička sredina, median i standardna devijacija). Za provjeru hipoteze o povezanosti među varijablama korišten je Hi-kvadrat test. Razine značajnosti bile su postavljene na pet posto, a granica pouzdanosti svih statističkih testova na 95 posto.

## Rezultati

Uzorak se sastojao od 120 zuba 40 pacijenata. Na njima je bilo 230 površina restauriranih kompozitom. Ispitanici, većinom žene (57,5 %), bili su u dobi od 16 do 60 godina. S restauriranim površinama bilo je više maksilarnih (73,3 %) nego mandibularnih (26,7 %) prednjih zuba. Većina je bila rekonstruirana prije jedne do pet godina, a najčešći PRRI-indeks retencije plaka iznosio je III (30,4 %) i IV (33,9 %). Većina površina (83,0 %) imala je hrapavu površinu, 46,5 posto kaviteta bilo je III. klase, 62 posto imalo je subgingivne rubove, a kod 38,6 posto pronađen je višak restaurativnog materijala. Aproximalni kontakt uočen je na većini (78,3 %) restauriranih površina, slijede prekonturiranje (32,6 %) i potkonturiranje (20,4 %), višak (38,3) ili manjak (33 %) restaurativnog materijala te primjereno rubno zatvaranje kod 30,4 posto uzoraka (tablica 2.).

Pronađena je značajna povezanost između stupnja zadržavanja biofilma i hrapavosti površine ( $p < 0,01$ ; tablica 3.). Vrijeme proteklo od postavljanja restauracije također je povezano s hrapavošću površine ( $p < 0,01$ ; tablica 4), što pokazuje da se ona s vremenom povećava. Vanjska svojstva ispuna (prekonturiranje, manjak restaurativnog materijala, zubno-

The degree of dental biofilm retention on resin-restored surfaces was evaluated using an aqueous solution of 2% basic fuchsin and recorded in each area using the Plaque Retention and Extension in Restoration Index (PRRI), (19), (Table 1).

Analyses were performed using descriptive statistics (mean, median, and standard deviation). Inferential statistics used the chi-squared test to verify the hypothesis of a significant association between variables. A 5% level of significance and 95% confidence intervals were used for all statistical tests.

## Results

The sample comprised 120 teeth with 230 resin-restored surfaces in 40 patients. The subjects were aged 13–60 years and most of them (57.5%) were female. More maxillary (73.3%) than mandibular (26.7%) anterior teeth had restored surfaces.

Most surfaces analysed had been placed 1–5 years previously and the most prevalent PRRI biofilm retention scores were III (30.4%) and IV (33.9%). Most (83.0%) surfaces exhibited roughness, 46.5% of cavities were class III, 62.2% of samples had subgingival margins, and 38.6% retained excessive restorative material. Proximal contact was present on most (78.3%) of the restored surfaces, over- and under-contouring were observed on 32.6% and 20.4% of surfaces, respectively, excess and lack of restorative material were found in 38.3% and 33% of cases, respectively, and an adequate tooth–restoration interface was observed in 30.4% of samples (Table 2).

A significant association was observed between the degree of biofilm retention and surface roughness ( $p < 0.01$ ; Table 3). The time elapsed since placement was also associated significantly with surface roughness ( $p < 0.01$ ; Table 4),

**Tablica 2.** Svojstva 230 smolom restauriranih površina  
**Table 2** Characteristics of 230 resin-restored surfaces.

Varijabla • Variable	N	%
Vrsta kaviteta • Type of cavity		
III	107	46,5
IV	63	27,4
V	60	26,1
Vrijeme proteklo od postavljanja • Time since placement		
1–11 mjeseci • months	85	37,0
1–5 godina • years	97	42,1
>5 godina • years	48	20,9
Rubovi • Margin		
Supragingivni • Supragingival	42	18,2
Gingivni • Gingival	45	19,6
Subgingivni • Subgingival	143	62,2
Hrapavost • Roughness		
Da • Yes	191	83,0
Ne • No	39	17,0
Stupanj zadržavanja biofilma • Degree of biofilm retention		
I	34	14,8
II	48	20,9
III	70	30,4
IV	78	33,9

Varijabla • Variable	N	%
Aproximalni kontakt • Proximal contact		
Da • Yes	180	78,3
Ne • No	50	21,7
Prekonturirano • Over-contoured		
Da • Yes	75	32,6
Ne • No	155	67,4
Podkonturirano • Under-contoured		
Da • Yes	47	20,4
Ne • No	183	79,6
Višak materijala • Excess of material		
Da • Yes	88	38,3
Ne • No	142	61,7
Manjak materijala • Lack of material		
Da • Yes	76	33,0
Ne • No	154	67,0
Spoj restauracija – zub • Tooth–restoration interface		
Da • Yes	70	30,4
Ne • No	160	69,6
UKUPNO • TOTAL	230	100

**Tablica 3.** Procjena zadržavanja biofilma prema grubosti restaurirane površine  
**Table 3** Assessment of biofilm retention according to restoration surface roughness.

Stupanj zadržavanja biofilma • Degree of biofilm retention	Hrapavost površine • Surface roughness				Ukupno • Total		p
	Da • Yes		Ne • No				
	n	%	n	%	n	%	
I	22	11.5	12	30.8	34	14.8	0.001*
II	44	23.1	4	10.2	48	20.9	
III	64	33.5	6	15.4	70	30.4	
IV	61	31.9	17	43.6	78	33.9	
Ukupno • Total	191	100	39	100	230	100	

\* Značajna razlika • Significant difference ( $p < 0.05$ )

<sup>1</sup> Hi kvadrat test • chi-squared test

**Tablica 4.** Procjena kaviteta, rubova preparacije, hrapavosti površine i stupnja zadržavanja biofilma, ovisno o vremenu proteklom od postavljanja restauracije  
**Table 4** Evaluation of the type of cavity, preparation margins, surface roughness, and degree of biofilm retention according to the time elapsed since restoration placement.

Varijabla • Variable	Proteklo vrijeme od postavljanja • Time since placement						Ukupno • Total		p <sup>1</sup>
	1–11 mjeseci • months		1–5 godina • years		>5 godina • years				
	n	%	n	%	n	%	n	%	
Vrsta kaviteta • Type of cavity									
III	35	41.2	50	51.5	22	45.8	107	46.5	0.677
IV	26	30.6	25	25.8	12	25.0	63	27.4	
V	24	28.2	22	22.7	14	29.2	60	26.1	
Rubovi • Margin									
Supraringivni • Supraringival	12	14.1	22	22.7	8	16.7	42	18.2	0.561
Gingivni • Gingival	17	20.0	20	20.6	8	16.7	45	19.6	
Gingivni • Subgingival	56	65.9	55	56.7	32	66.6	143	62.2	
Hrapavost • Roughness									
Da • Yes	58	68.2	87	89.7	46	95.8	191	83.0	<0.001*
Ne • No	27	31.8	10	10.3	2	4.2	39	17.0	
Stupanj zadržavanja biofilma • Degree of biofilm retention									
I	15	17.7	15	15.4	4	8.3	34	14.8	0.085
II	10	11.8	28	28.9	10	20.8	48	20.9	
III	28	32.9	28	28.9	14	29.2	70	30.4	
IV	32	37.6	26	26.8	20	41.7	78	33.9	
UKUPNO • TOTAL	85	100	97	100	48	100	230	100	

\* Značajna razlika • Significant difference ( $p < 0.05$ ).

<sup>1</sup> Hi-kvadrat test • Chi-squared test.

restauracijski spoj) bila su značajno povezana s vremenom proteklom od postavljanja ( $p < 0,05$ ; tablica 5.).

## Rasprava

Dobro obavljena zubna restauracija usko je povezana sa zdravljem zuba, uključujući prevenciju karijesa i parodontne promjene u okolnom tkivu, a poboljšava i estetiku te funkcionalnost usne šupljine. Restauracije koje nisu učinjene prema pravilima struke ili zanemaruju rizični čimbenik poput biofilma, mogu postati problematične i narušiti ravnotežu oralne šupljine. Rezultati iz ovog istraživanja to podupiru jer je pronađeno više plaka na restauracijama sa strukturnim pogreškama.

indicating that surface roughness increases with time elapsed from restoration placement.

Three external cavity preparation characteristics (overcontouring, lack of restorative material, tooth–restoration interface) were associated significantly with the time elapsed since placement ( $p < 0.05$ ; Table 5).

## Discussion

Properly executed dental restorations are closely related to dental health, including the prevention of dental caries and periodontal changes in adjacent tissues, and they improve the aesthetics and functionality of the oral cavity. However, dental restorations that are not performed following dentistry principles or neglect the presence of any risk factor, such as dental biofilm, can result in problems and disturb the balance of the oral cavity. These concepts are supported by the results of this study, which found a great-

**Tablica 5.** Procjena vanjskih svojstava preparacije kaviteta, ovisno o vremenu proteklom od postavljanja  
**Table 5** Evaluation of external cavity preparation characteristics according to time elapsed since placement.

Varijabla • Variable	Proteklo vrijeme od postavljanja • Time since placement						Ukupno • Total		p <sup>1</sup>
	1–11 mjeseci • months		1–5 godina • years		>5 godina • years		n	%	
	n	%	n	%	n	%			
UKUPNO • TOTAL	85	100	97	100	48	100	230	100	
Aproksimalni kontakt • Proximal contact									
Da • Yes	71	83.5	73	75.3	36	75.0	180	78.3	0.333
Ne • No	14	16.5	24	24.7	12	25.0	50	21.7	
Prekonturirano • Over-contoured									
Da • Yes	19	22.4	38	39.2	18	37.5	75	32.6	0.039*
Ne • No	66	77.6	59	60.8	30	62.5	155	67.4	
Potkonturirano • Under-contoured									
Da • Yes	14	16.5	20	20.6	13	27.1	47	20.4	0.345
Ne • No	71	83.5	77	79.4	35	72.9	183	79.6	
Višak materijala • Excess of material									
Da • Yes	32	37.6	37	38.1	19	39.6	88	38.3	0.975
Ne • No	53	62.4	60	61.9	29	60.4	142	61.7	
Manjak materijala • Lack of material									
Da • Yes	22	25.9	29	29.9	25	52.1	76	33.0	0.006*
Ne • No	63	74.1	68	70.1	23	47.9	154	67.0	
Spoj restauracija –zub • Tooth–restoration interface									
Da • Yes	51	60.0	18	18.6	1	2.1	70	30.4	<0.001*
Ne • No	34	40.0	79	81.4	47	97.9	160	69.6	

\* Značajna razlika • Significant difference (p < 0.05).

<sup>1</sup> Hi-kvadrat test • Chi-squared test.

U nekoliko istraživanja *in vivo* (1, 2, 16, 20 – 25) i *in vitro* (5, 6) istaknuto je da vrijeme proteklo od postavljanja restauracije (mjereno mjesecima i godinama) utječe na površine s nekoliko strukturnih problema, poput zadržavanja biofilma, sekundarnog karijesa, fraktura i promjena anatomskog oblika. Neki autori tvrde da su dulji razmaci od postavljanja restauracije povezani s većom vjerojatnošću uočavanja tih problema, premda se mogu naći i kod tek obavljenih radova, što kompromitira njihovu trajnost (1, 2, 16, 20 – 25). Naši rezultati slažu se s nalazima iz prijašnjih istraživanja jer smo ustanovili da je vrijeme proteklo od postavljanja restauracije znatno povezano sa stupnjem zadržavanja biofilma. Premda je posljednjih desetljeća postignut velik napredak u tehnikama i proizvodnji materijala kojima se liječnici koriste u restaurativnoj dentalnoj medicini, smolasti materijali i dalje imaju visok stupanj zadržavanja biofilma (3, 9–11, 26–31). Proizvođači se neprestano trude razviti bolje i kvalitetnije smolaste materijale, uglavnom radi smanjenja hrpaivosti površine. Dodaju u njih i samočistače i antibakterijske spojeve kako bi se preveniralo zadržavanje pojedinih mikroorganizama, poput bakterije *Streptococcus mutans*. Rezultati dobiveni u tim istraživanjima slažu se s dosadašnjim studijama u kojima je uočeno značajno nakupljanje biofilma (plak) na restauriranim površinama, što je znak da dodavanje antimikrobnih spojeva u smolaste materijale ne zadovoljava (3, 9–11, 26–31).

Dobra restauracija mora imati sljedeća svojstva: aproksimalni kontakt, ne smije biti prekonturirana ili potkonturirana, nije dopušten višak ili manjak materijala i mora se postići savršena veza materijala i zuba. Podatci dobiveni iz ovog

er degree of biofilm retention on restorations with structural failures.

Several *in vivo* (1,2,16,20-25) and *in vitro* (5,6) studies have shown that the time elapsed since restoration placement (measured in months or years) tends to be associated with the presence of surfaces with several structural problems, such as biofilm retention, secondary caries, fracture, and changes in anatomical shape. Some studies have shown that longer intervals from placement are associated with a greater probability of observing these problems, although these conditions can also be found in recent restorations, where they compromise longevity (1, 2, 16, 20-25). Our results support those of previous studies; we found that the time elapsed since restoration placement was associated significantly with the degree of biofilm retention.

Although advances in the techniques and materials used in restorative dentistry have been made in recent decades, resin materials continue to show a high rate of biofilm retention (3, 9-11, 26-31). Manufacturers continue making efforts to develop better-quality resin materials, mainly by reducing surface roughness. They are also adding self-cleaning and antimicrobial substances to prevent the retention of certain strains of microorganism, such as *Streptococcus mutans*. The results presented in this study are consistent with previous findings of significant dental biofilm (plaque) accumulation on restoration surfaces, indicating that the addition of antimicrobial agents to resin materials has not achieved the manufacturers' desired results (3, 9-11, 26-31).

An adequate restoration must have the following characteristics: proximal contact, absence of over- and under-con-

istraživanja pokazali su neuspjeh na većini analiziranih restauriranih površina, a na istim restauracijama uočeno je i nekoliko nedostataka. U dosadašnjim istraživanjima (1, 16, 32, 33) analizirani su isti restaurativni materijali te je zapaženo da se nedostaci i dalje pojavljuju, unatoč tehničkom poboljšanju materijala. Naime, materijali su i dalje pogodni za zadržavanje biofilma, što kompromitira oralno zdravlje pojedinaca. Visok stupanj neuspjeha potvrđen je i u ovom istraživanju.

U vezi s tim stručnjaci moraju razviti vještine koje će im omogućiti obavljanje restaurativnih zahvata koji će pridonijeti oralnom zdravlju i dugotrajnosti restauracije. Pacijent također mora kontrolirati zadržava li se biofilm na restauraciji i održavati je pravilnom oralnom higijenom.

## Zaključak

U ovom istraživanju većina je restauriranih površina zadržala visok stupanj biofilma (PRRI-vrijednosti III i IV), što je povezano s hrapavošću površine restaurativnih materijala. Vrijeme proteklo od postavljanja ispuna utječe na hrapavost površine i stupanj zadržavanja biofilma.

## Sukob interesa

Autori ističu da nisu bili u sukobu interesa.

touring, no excess or lack of material, and perfect bond at the tooth–restoration interface. The data obtained in this study showed significant failure rates on most restored surfaces analysed, and several failures were often noted on the same restored surface. Previous studies (1, 16, 32, 33), have analysed the same restorative material characteristics and noted that failures continue to occur, despite the technical evolution of restorative materials; the materials continue to favour biofilm retention, which compromises the oral health of the individual. This high failure rate was confirmed in the present study.

Within this context, professionals must develop skills enabling them to perform restorative procedures that provide adequate oral health status with treatment longevity. The patient must also control biofilm accumulation and maintain the restoration by using adequate oral hygiene techniques.

## Conclusion

In this study, most restored surfaces showed a high degree of biofilm retention (PRRI scores of III and IV) that was associated significantly with the presence of surface roughness on restorative materials. The time elapsed since the placement of resin restorations was found to influence surface roughness and the degree of biofilm retention.

## Conflict of Interests

There is no conflict of interest in this paper.

### Abstract

**Objective:** The aim of this study was to evaluate associations of biofilm retention on resin-restored surfaces of anterior teeth with quality and time elapsed since placement. **Methods:** The study sample comprised 120 teeth with 230 restored surfaces in 40 patients of both sexes aged 16–60 years. The Plaque Retention and Extension in Restoration Index (PRRI) was used to measure the degree of biofilm retention, and the surface roughness of the material, cavity type and margins, and external cavity preparation characteristics were also evaluated. **Results:** Most surfaces analysed had been placed 1–5 years previously. The most prevalent PRRI biofilm retention scores were III and IV, 83.0% of samples presented surface roughness, 46.5% of cavities were class III, 62.2% of surfaces had subgingival margins, and 38.6% retained excessive restorative material. Surface roughness was significantly associated with the degree of biofilm retention and time elapsed since placement (both  $p < 0.01$ ). Three external cavity preparation characteristics (over-contouring, lack of restorative material, tooth–restoration interface) were also associated significantly with the time elapsed since placement (all  $p < 0.05$ ). **Conclusion:** The time elapsed since the placement of resin restorations influences surface roughness and the degree of biofilm retention.

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### Key words

Dental Cavity Preparation; Composite Resin; Surface Properties; Biofilms

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