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The New Classification of Periodontal Diseases (2018) Parameters and Mechanical Plaque Control After 12 Months of Proper Marginal Nanofilled, and Nanohybrid Composites Resin Restorations among Smokers Diabetic Patients

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Abstract

Background: There is a shortage of publications on the values of the periodontal clinical parameters and mechanical plaque control of Nanofilled and nanohybrid composite resin restorations among smokers diabetic patients.

Objective: The current study aimed to assess the new classification of periodontal diseases (2018) parameters and mechanical plaque control after 12 months of proper marginal Nanofilled, and nanohybrid composites resin restorations among smokers diabetic patients.

Materials and Methodology: A total of 120 proper marginal Nanofill composite restorations on anterior teeth and 120 proper marginal nanohybrid composite restorations on posterior teeth of sixty adult smokers diabetic patients within two equal groups (n = 30), as well as 30 adult smokers diabetic patients as a control group (without fillings) who were brushing their teeth two times daily, were selected from outpatient clinics of the college of dentistry, King Khalid University and from the patients referred to some private dental clinics outside the college of dentistry, King Khalid University. All clinical parameters were recorded after 12 months of restorations and periodontal therapy. The data were collected and analyzed using the ANOVA test, and Chi-Square (P = 0.05).

Results: The results revealed that the lowest periodontal clinical parameters values of plaque and gingival status (PCR and GBI) were recorded adjacent to nanohybrid composite restorations, whereas the values of periodontitis clinical parameters (CAL and RBL) were the highest compared to Nanofill composite restorations. The complexity and modalities values of periodontitis were higher at the adjacent nanohybrid composite restorations than at the adjacent Nanofill composite restorations after 12 months. There were no statistically significant differences in the clinical periodontal parameters values between anterior and posterior teeth composite dental fillings (Nanofill and nanohybrid) after 12 months ($p > 0.5$).

Conclusion: Nanofill and nanohybrid composite restorations showed a no acceptable clinical impact on periodontal tissues of smokers diabetic patients, but the effect of nanohybrid composite restorations was more than Nanofill composite restorations according to the updated periodontal diseases classification (2018) criteria.

Keywords: *Diabetic Patients; Mechanical Plaque Control; Nanohybrid Composite; Nanofill Composite; Periodontal Parameters; Smokers*

Introduction

Diabetes mellitus is a metabolic disorder due to the lack of insulin secretion by the pancreas or lack of insulin action on target tissues leading to dysfunctions and fail of some organs in the body [1]. Periodontal diseases are a group of inflammatory diseases caused by bacterial plaque, which may trigger off the destruction of periodontal tissues and loss of teeth [2]. There are other risk factors for many diseases, such as diabetes and tobacco smoking and some evidence confirmed that smoking negative impacts periodontal status [3].

Composite resin is the most widely used restorative material directly, comprising matrix and filler particles that impact the finishing and polishing result [4]. In 1962 Bowen introduced composite resin as a new restorative dental material, then modified and improved more than other restorative material [5]. The usage of composite resin for posterior teeth direct restoration is increasing in restorative dentistry due to the noninvasive conservative and esthetic outcomes [6]. The hybrid composite is used for routine anterior and posterior restorations due to it is the best blend of good material characteristics and clinical appearance [7].

The use of nanotechnology in the composite resins provides high polish, high translucency, and high gloss, as well as appropriate mechanical and clinical characteristics for tolerance of high stress and less dental plaque formation [8,9]. Consequently, it is available in two types Nanofilled and nanohybrid in the market, according to the containing nanofillers in composite resin where Nanofilled composites consist of nano-clusters and nano-fillers whereas nanohybrid composites consist of hybrid fillers and nano-fillers [10], [11]. Multiple-surface fillings on permanent posterior teeth are the most frequent types of fillings where caries occurs at the occlusal surfaces, then extend to the proximal surfaces [12].

In past decades and although several types of research about the clinical outcomes of composite resin usage in posterior teeth, assessment of composite resin direct usage and buildups in anterior within have been rare [13,14]. As we know, the clinical success of composite resin restorations depends on their surface quality, where the smooth surface can help esthetics and immortality of fillings by reduction of plaque accumulation because the rough surface plays a significant role in plaque accumulation and can increase the risk of periodontal diseases [15,16]. Moreover, more research revealed that restoration margins have always been appropriate areas for plaque aggregation and the proliferation of bacteria leading to periodontal tissues destruction [17,18].

Mechanical plaque control is the most popular treatment for the maintenance of periodontal health [19,20]. Tooth brushing and flossing are essential mechanical oral hygiene methods for microbial plaque control in the oral cavity [21]. Both procedures can change the smoothness of the restoration surface, even resulting in inadmissible roughness that can raise plaque collection and the risk of dental caries and periodontal diseases [20,22].

The existence of restorations without an optimal polish or smoothness state adjacent to the periodontal tissues may accelerate plaque accumulation and, consequently, the development of periodontal diseases [23]. An increase of pro-inflammatory cytokines during periodontal diseases may be lead to changes in the lipids metabolism, and hyperlipidemia may produce of β cells destruction in the pancreas, consequently the development of diabetes [2].

Objective of the Study

The objective of this study was to evaluate the impact of mechanical plaque control and proper marginal Nanofilled and nanohybrid composite resin restorations on clinical periodontal parameters after 12 months due to the importance of metabolic control for periodontal health among smokers diabetic patients.

Materials and Methods

Study population and design

90 smoker diabetic patients (47 males and 43 females) with a total of 120 proper marginal Nanofill composite restorations on anterior teeth and 120 proper marginal nanohybrid composite restorations on posterior teeth of sixty adult smoker diabetic patients within two equal groups (n = 30), as well as 30 adult smoker diabetic patients as a control group (without fillings) all in the age group ranging between 21 - 61 years were selected from the patients referred to the outpatients' dental clinics at college of dentistry, King Khalid University and from the patients referred to some private dental clinics outside the college of dentistry, King Khalid University. This study was conducted during the period from March 2022 to June 2022. The participants for the study were selected according to inclusion and exclusion criteria. The diabetic participants in good systemic health and without other relevant medical history were checked for the presence of at least one tooth presenting with proper marginal Nanofilled or nanohybrid composites resin restorations. All participants were subjected to non-surgical periodontal therapy (scaling, polishing, and root planing) and composite resin restoration before 12 months (Figure 1-4).

Figure 1: *Clinical view of the periodontal status of the anterior teeth prior to the restoration of composite resin nanofill.*

Figure 2: *Clinical view of the periodontal status of the anterior teeth 12 months after a nanofill composite resin restoration.*

Figure 3: *Clinical view of the periodontal status of the posterior teeth prior to the restoration of composite resin nanohybird.*

Figure 4: *Clinical view of the periodontal status of the posterior teeth 12 months after a nanohybird composite resin restoration.*

Inclusion criteria

Inclusion criteria were as follows: The participants who were older than 18 years, no pregnant or lactating participants, smokers and diabetics' participants, high levels of compliance among participant [24] and presence of at least one tooth presenting with interproximal Nanofilled or nanohybrid composites resin restorations participants.

Exclusion criteria

Exclusion criteria were as follows: Non-diabetic and non-smokers participants, the participants who used anti-inflammatory drugs, unstable participants with life-threatening conditions, the participants with conditions requiring antibiotic prophylaxis, the participants with debilitating diseases such as cancer and autoimmune diseases, the participants who used systemic antibiotics in the past 6 months of periodontal evaluation, the participants who used drugs that induced gingival enlargement, the participants who refused the signature on the consent form, the participants who have incorrect marginal or the overhang or unsuitable contour of Nanofilled and nanohybrid

composite resin, the diabetic participants should be free of any other systemic diseases, pregnant or lactating participants or users of contraceptives or any other kind of hormone replacement therapy.

Sample size

A formula of clinical studies was applied to determine the sample size of the present study, where the restorations were 120 on anterior teeth and 120 on posterior teeth according to clinical studies recommendations of the American Dental Association.

Ethical status

The ethical clearance certificate of the study was obtained from the institutional review board, college of dentistry, King Khalid University (IRB/KKUCOD/ETH/2021-22/039). All participants signed on with written informed consent and understood the nature of the research before the study started according to the guidance of Helsinki protocols [25].

Clinical and radiographic evaluation

The clinical and radiographic examination was done by the researchers with Williams periodontal probe to determine: Plaque control record (PCR) [26], gingival bleeding index (GBI) [27], clinical attachment loss (CAL), periodontal pocket depth [28] as well as missing teeth due to periodontal diseases, tooth mobility [29] and percentage of radiographic bone loss. The calibrated measuring tool of Emago® was used to calculate the percentages of radiographic bone loss in millimeters by the difference between the distance from the cement-enamel junction (CEJ) to the alveolar bone crest (ABC) as well as the distance from CEJ to the root apex multiplied by 100 [30,31]. Glycosylated hemoglobin more, or less than 7%, was recorded from the medical reports of participants [32].

Statistical analysis

The clinical findings were collected and tabulated, and the ANOVA test and Chi-square were used to detect the significant differences among the study groups. P-value at ≤ 0.05 was considered a significant standard ($p \leq 0.05$).

Results

This study included 90 participants, comprising 47 (52.2%) males and 43 (47.8%) females. Group I patients in the present study were aged between 21and 62 years with a mean and standard deviation (38.6 ± 12.5), group II patients were aged between 15 and 60 years with a mean and standard deviation (38.7 ± 10.5), while group III patients were aged between 17 and 60 years with mean and standard deviation (39.7 ± 11.8), Group III participants in the present study had mean ages more than the participants of group I and II without statistically significant differences detected ($p > 0.5$) (Table 1 and figure 5).

	Age		ANOVA	
	Range	Mean ± SD	F	P-value
Group I	21 - 62	38.6 ± 12.5	0.082	0.921
Group II	15 - 60	38.7 ± 10.5		
Group III	17 - 60	39.7 ± 11.8		

Table 1: *The mean and standard deviation of ages.*

SD: Standard Deviation.

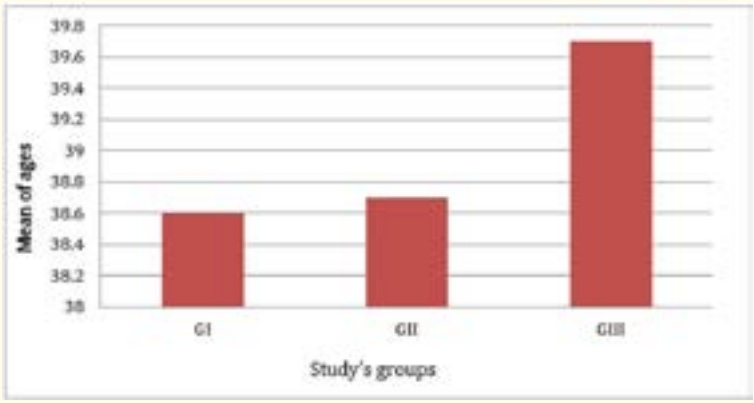

Figure 5: *The mean and standard deviation of ages.*

GI: Group I, GII: Group II, GIII: Group III

The clinical parameters of periodontal disease staging of the participant groups in this study are shown in table 2 and figure 6 and 7, such as plaque control record, gingival bleeding index, clinical attachment loss, percentage of radiographic bone loss, and periodontal pocket depth. The mean of these parameters showed no significant differences between groups ($p > 0.05$), although the clinical examination revealed more value of the mean of plaque control record, gingival bleeding index (67.5 ± 19.01 and 53.2 ± 28.9, respectively) between the participants of group II more than group I (64.9 ± 25.7 and 41.9 ± 27.1) and III (65.3 ± 19.4 and 49.8 ± 25.03, respectively). Moreover, the mean of clinical attachment loss (5.3 ± 1.2) among the participants of group III was more than groups I and II (5.2 ± 1.5 and 4.6 ± 1.7, respectively), whereas the percentage of radiographic bone loss and periodontal pocket depth (40.3 ± 13.9 and 4.12 ± 1.6, respectively) between the participants of group I more than group III (38.13 ± 14.52 and 3.5 ± 0.9, respectively) and group II (37.1 ± 14.9 and 3.5 ± 0.8, respectively).

Items		Groups			ANOVA	
		Group I	Group II	Group III	F	P-value
PCR	Range	11.1-100	33-95.6	27-98	0.126	0.882
	M ± SD	64.9 ± 25.7	67.5 ± 19.01	65.3 ± 19.4		
GBI	Range	2-96.9	6.4-94.7	12-92	1.378	0.258
	M ± SD	41.9 ± 27.1	53.2 ± 28.9	49.8 ± 25.03		
CAL	Range	2-10	0-7	3-8	1.491	0.231
	M ± SD	5.2 ± 1.5	4.6 ± 1.7	5.3 ± 1.2		
%RBL	Range	14.2-73.4	16.6-81	2-67	0.339	0.714
	M ± SD	40.3 ± 13.9	37.1 ± 14.9	38.13 ± 14.52		
PPD	Range	2-8	2-6	1-5	3.098	0.05
	M ± SD	4.12 ± 1.6	3.5 ± 0.8	3.5 ± 0.9		

Table 2: *Clinical parameters of staging periodontal diseases.*

PCR: Plaque Control Record; GBI: Gingival Bleeding Index; CAL: Clinical Attachment Loss; %RBL: Percentage of Radiographic Bone Loss; PPD: Periodontal Pocket Depth.

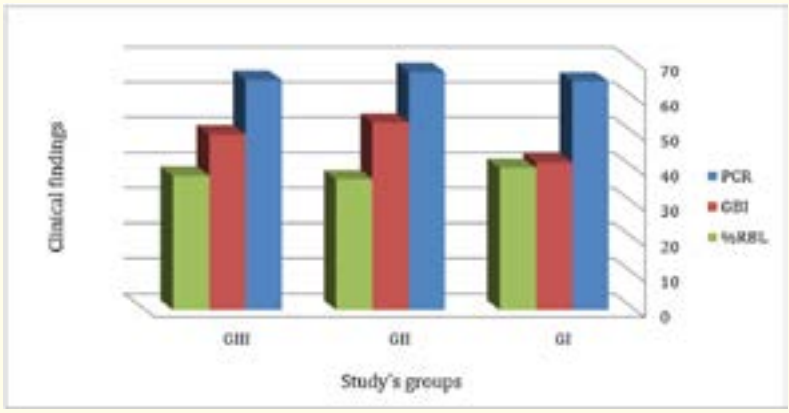

Figure 6: *Plaque control record, gingival bleeding index and percentage or radiographic bone loss.*
GI: Group I, GII: Group II, GIII: Group III, PCR: Plaque Control Record; GBI: Gingival Bleeding Index; %RBL: Percentage of Radiographic Bone Loss.

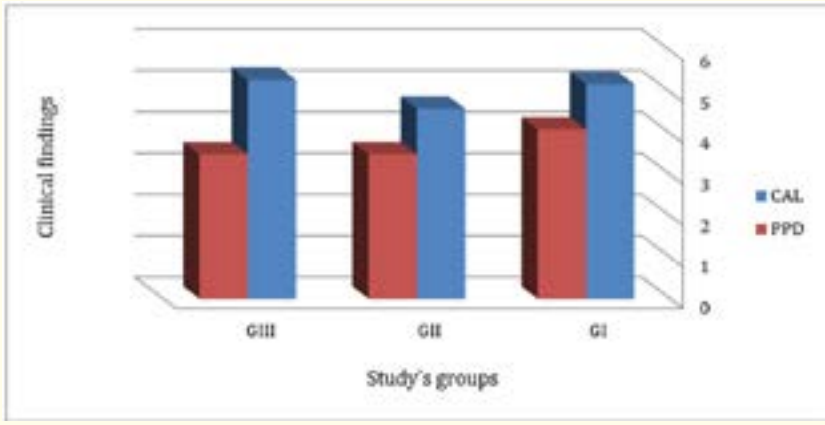

Figure 7: *Clinical attachment loss and periodontal pocket depth.*
GI: Group I, GII: Group II, GIII: Group III; CAL: Clinical Attachment Loss; PPD: Periodontal Pocket Depth.

The mean and standard deviation of some clinical findings of periodontal disease staging complexity (More than 5 missing teeth due to periodontal diseases and Tooth mobility) were summarized in table 3 and figure 8. The mean values of missing teeth due to periodontal diseases (> 5MT) and the mean values of tooth mobility (TM) in groups II and III were compared with the mean values between group I (control group), where the abnormality in (> 5MT) among the participants in group I (20%) more than group II (16.7%) and group III (6.7%), whereas the abnormality in (TM) among the participants in group III (40%) more than in group I (30%) and group II (26.7%). The comparison of some clinical findings of periodontal disease staging complexity between groups I, II, and III in the current study was not statistically significant (p > 0:05).

n = 30		Groups			Chi-square	
		Group I n = 30	Group II n = 30	Group III	X^2	P-value
> 5MT	D	6 (20%)	5 (16.7%)	2 (6.7%)	2.577	0.276
	ND	24 (80%)	25 (83.3%)	28 (93.3%)		
TM	D	9 (30%)	8 (26.7%)	12 (40%)	1.118	0.572
	ND	21 (70%)	22(73.3%)	18 (60%)		

Table 3: *Some clinical parameters of periodontal diseases staging complexity.*

> 5MT: More than 5 missing teeth due period diseases, TM: Tooth Mobility, D: Abnormality Detected, ND: No Abnormality Detected.

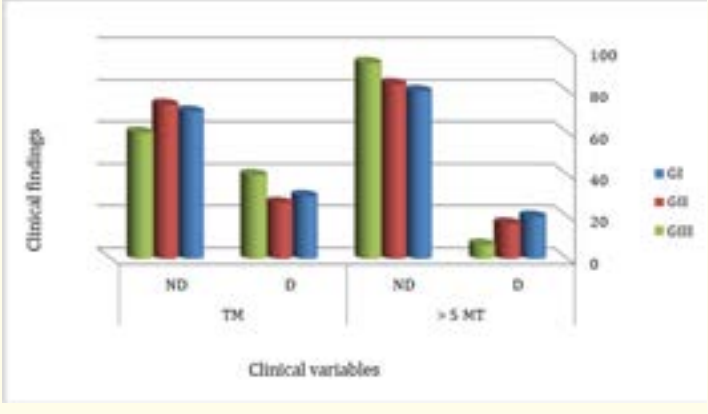

Figure 8: *Some clinical findings of periodontitis staging complexity.*

GI: Group I, GII: Group II, GIII: Group III, > 5MT: More than 5 missing teeth due period diseases, TM: Tooth Mobility; D: Abnormality Detected; ND: No Abnormality Detected.

Table 4 and figure 9 exhibit the clinical findings of periodontal disease modalities in the present study. The percentage among the participants in the current study of the glycated hemoglobin test value of more than 7% in group I (46,7%) was higher than that of groups (43.3%) II and III (43.3%). The percentage among the participants in the current study of the number of cigarettes more than 10 cigarettes smoked per day in group III (56.7%) was even higher than in group II (53.3%) and a group I (46,7%). Table 4 and figure 5 results showed that there are no statistically significant differences in the clinical findings of periodontal disease modalities between the study groups (p > 0:05).

n = 30		Groups			Chi-square	
		Group I n = 30	Group II n = 30	Group III	X^2	P-value
HbA1c test	< 7% HbA1c	16 (53.3%)	17 (56.7%)	17 (56.7%)	4.754	0.093
	> 7% HbA1c	14 (46,7%)	13 (43.3%)	13 (43.3%)	2.114	0.347
No cig/day	< 10cig	16 (53.3%)	14 (46,7%)	13 (43.3%)	1.549	0.461
	> 10cig	14 (46,7%)	16 (53.3%)	17 (56.7%)		

Table 4*: Clinical findings of periodontal diseases modalities.*

HbA1c: Glycated Hemoglobin Test; No cig/day: Number of Cigarettes Smoked Per Day.

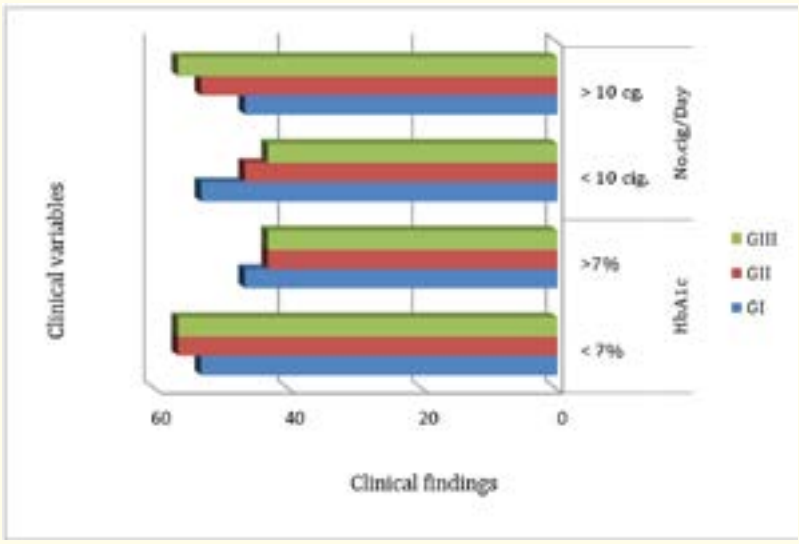

Figure 9: *Clinical findings of periodontitis modalities.*

HbA1c: Glycated Hemoglobin Test; No cig/day: Number of Cigarettes Smoked Per Day.

Discussion

The relationship between dental restorations and periodontal tissues should be confident, so the periodontal tissues should continue good status till restorations last for long periods [33]. Composite resin restorations might be subject to the impact of oral hygiene mechanical and chemical measures leading to physical changes in surface characteristics of restorations [34]. Usually, the surfaces of these restorations are different based on their structure and characteristics, such as filler particle concentration, shape, and size [35]. Composite resin restorations adjacent to periodontal tissues may assist in bacterial plaque accumulation, which is the initial etiologic factor of periodontal diseases [36]. Periodontal disease is more common and intense among diabetic than non-diabetic patients, and periodontal complications are considered the sixth conventional complication in diabetic patients [37].

Previous studies have reported that tooth brushing with dentifrice plays a significant role in decreasing plaque formation and composite resin restoration wear, and the amount of wear depends on some factors related to the tooth brushing technique and characteristics of composite restoration components [38,39]. The present study assessed the impact of mechanical plaque control after 12 months of proper marginal Nanofilled, and nanohybrid composites resin restorations on the new classification of periodontal diseases (2018) parameters among smokers diabetic patients. In the present study, all plaque control record values of Nanofilled restorations were more than nanohybrid composites resin restorations throughout the assessment interval due to the friction with food and opposing teeth during mastication, which was in disagreement with the clinical findings of the previous study revealed that the greater masticatory forces on occlusal surfaces of posterior teeth resulting in increased surface roughness of the restorations Nanohybrid composite resin restorations after 12 months [40].

As we know, plaque index reflects the oral hygiene status where some previous studies revealed that smokers had high plaque index without statistically significant differences and these results agree with the results of the present study [41,42], whereas other studies

showed less plaque index in smokers may be explained that the tooth brushing was incorrect among the participants, especially in the retentive areas of dental plaque such as dental restorations [43-45]. Some studies show increased inflammation among smokers [46-48], these results are in agreement with the results of the present study, which may be due to the plaque effect.

The alterations of the host immune response among diabetic patients with the presence of dental plaque resulting severe destruction of gingival and periodontal tissues [49]. Some previous studies reported that put of composite resin restorations adjacent to the gingival margin resulting gingival inflammation [50,51]. Besides, the present study revealed a correlation between the presence of Nanofilled and nanohybrid composites resin restorations close to gingival tissues causing gingival bleeding in the participants more than the participants with the absence of these composites resin restorations. On the other hand, this study showed that there is no association between distribution and severity of gingival diseases and Nanofilled and nanohybrid composites resin restorations where grade 4 of plaque-induced gingivitis appeared among the participants of study groups, in contrast to grade 3 of plaque-induced gingivitis appeared among the participants of the control study group.

In the present study, the clinical differences were not very significant. Nevertheless, there were differences in plaque control record, Gingival bleeding index, clinical attachment loss, percentage of radiographic bone loss, periodontal pocket depth, number of missing teeth due to periodontal diseases, and tooth mobility after 12 months among group II and III participants who had subjected to mechanical plaque control and Nanofilled, and nanohybrid composites resin restorations, and no statistically significant differences were detected. Consequently, the proper marginal Nanofilled and nanohybrid composites resin restorations did not affect the new classification of periodontal diseases (2018) parameters with the presence of tobacco smoking and diabetes mellitus, which impacted these clinical parameters in the two groups, these results are in agreement with the results of the previous study which revealed identical clinical finding after a short of time [52]. The clinical findings may be due to the changes in the surfaces of Nanofilled and nanohybrid composites resin restorations that occur as a result of exposure to some local factors such as saliva, mechanical plaque control, and carbon-nitrogen-rich conditioning film [53]. At the end of 12 months, the periodontal parameters, periodontal response, and oral hygiene status revealed clinical findings are similar to the report of a previous study that exhibited a passive impact of composite resin restorations on periodontal tissues and oral hygiene status [54].

Strength and Limitations

Regarding the strength and limitations of this study, there was no statistically significant difference between the study groups (group II and group III) and the control group (group I). It should be mentioned that there were differences in periodontal parameters. Indeed, the minor changes in the clinical parameters of periodontal tissues adjacent to nanohybrid composites resin restorations compared to the clinical parameters of periodontal tissues adjacent to Nanofilled composites resin restorations. In this study, incorrect daily tooth brushing may have changed the surface of composite resin restorations. Consequently, the postoperative surface roughness of composite resin restoration may occur. For the periodontal response, clinical periodontal parameters alterations were detected in all groups. These values have not changed statistically significantly differences over time. There were some limitations within the present study, such as the low number of participants, the uncooperative of some participants and not standardizing the class of Nanofilled and nanohybrid composites resin restorations, and not determining the duration and method of tooth brushing as well as not determine the toothpaste of regarding abrasiveness system and not determine another bad habit such tobacco chewing, qat chewing and gum chewing and other oral bad habits which may cause a change in oral microbiota nature, saliva pH and the surface of composites resin restorations over a long period after restorations

Conclusion

At the end of the study, we conclude that after 12 months, there was no unfavorable effect of proper marginal Nanofilled and nanohybrid composites resin restorations on periodontal tissues of smokers with diabetes mellitus, irrespective of mechanical plaque control.

The proper marginal Nanofilled and nanohybrid composites resin restorations among smokers and diabetic patients revealed unacceptable clinical performance due to the poor general health of participants. There were no significant differences between the three groups tested. There is a need to assess restorations with additional microbiological, histopathological, and immunological studies to evaluate the long time clinical performance of these resin composite materials among smokers and diabetic patients.

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Conflicts of Interest

There are no conflicts of interest.

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