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The Effect of the Different Service Lives of Class II Amalgam Restorations on Periodontal Health among Type 2 Diabetes Patients

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Abstract

Background: This comparative cross-sectional study evaluated the effect of the different service lives of class II amalgam restorations on periodontal health among type 2 diabetes patients.

Methods: Two hundred and twenty-five diabetics were divided into five groups (G1-G5) based on the ages of their class II amalgam restorations, i.e., 2, 4, 7, 10, >10 years, respectively. Each group had 45 patients, aged 45-60. They were assessed for the plaque index (PI), gingival index (GI), rate of overhangs (OH), and alveolar bone loss (ABL) (OH and ABL; using panoramic X-ray). The data were analyzed by the Scheffé test and analysis of variance.

Results: The mean HbA1c results among the examined groups ranged from 7.8% to 11%.The groups' mean durations of diabetes (± SD) were 2.1 (SD 0.33), 4.3 (SD 0.36), 9 (SD 1.2), 12.5 (SD 0.9), and 12 (SD 0.84), respectively. The periodontal scores were high (worse periodontal parameters), ranging from 42% to 59.5% for ABL, 2.45 to 2.95 for PI, and 2.25 to 2.8 for GI. The highest scores were recorded in G4 and G5 ($p<0.001$). The highest rate of overhangs was recorded in G4 ($p<0.001$).

Conclusion: Class II amalgam restorations seemed to affect the periodontal health status of patients with diabetes. Furthermore, longer service life of these restorations (≥ 10 years) and longer diabetes duration were accompanied by the worst periodontal parameters, indicating severe periodontal destructions and worse periodontal health status.

Keywords: Diabetes mellitus; Class II amalgam restorations; Alveolar bone loss; Plaque index; Gingival index

Introduction

Periodontal disease is a chronic inflammatory illness that affects the soft and the hard supporting structures surrounding the teeth [1]. It is one of the most prevalent diseases related to the oral cavity that can cause tooth loss among adults [2,3]. The primary initiating factor for the destructive form of periodontal disease is the accumulation and maturation of the dental plaque biofilm around teeth [4]. Periodontal disease causes painful chewing, bleeding, swollen gums (gingivitis), gum tenderness, pain, and bad breathe [5]. Its advanced form can cause periodontal ligament destruction and alveolar bone loss [1,6].

The resorption of the bony structure surrounding the teeth is a complex biological process known as alveolar bone loss; it results in bone shrinkage [6]. Furthermore, it is a process by which the osteoclasts decompose the hard tissues of the bone, causing the calcium to be transferred from the bone tissues to the blood [7]. Alveolar bone loss, one of the hallmarks of periodontitis, is highly prevalent among humans, affecting 90% of the worldwide population [8]. The exact reason for advanced alveolar bone loss is frequently unknown. However, predisposing risk factors, such as periodontitis, trauma, infection secondary to caries, and lost teeth left unreplaced, may cause the majority of premature alveolar bone loss cases [9]. In fact, the alveolar bone loss should be assessed in patients, especially elderly subjects, with systemic diseases, such as diabetics and periodontal complication cases. The assessment of alveolar bone loss among these candidates is important because, if not diagnosed and treated at an earlier stage, the consequences may be detrimental, such as tooth loss [10]. Additionally, it aids in determining the prognosis and relevant treatment plan [11].

Diabetes mellitus is a chronic complex metabolic disorder and a well-known underlying risk factor for several oral complications. There is clear evidence indicating that diabetes and periodontitis are correlated with chronic diseases [12,13]. This bidirectional relationship suggests that patients with diabetes are more prone to periodontal complications and that those with periodontitis are more susceptible to diabetes mellitus [14,15]. Various previous research studies that examined the periodontal health among patients with diabetes have revealed far worse periodontal parameters as well as various periodontal complications, especially among poor glycemic control individuals as compared to their non-diabetic controls [16-21]. Being the most significant risk factor for periodontal infection [20], diabetes can work synergistically with other risk factors, thereby aggravating periodontal disease's destructive process. One of these detrimental risk factors is faulty class II amalgam restoration.

An improperly restored or over-hanged class II amalgam restoration is one of the most important iatrogenic factors for plaque deposition and the subsequent gingival inflammation [22]. Faulty restoration not only creates an ideal location for plaque accumulation but also increases the number of periodontal pathogens in the plaque [23,24]; this increase has the potential to alter the ecological balance of the gingival sulcus zone, leading to alterations in the associated microbiota [25]. The consequences of such pathogenic multiplication and the subsequent tissue inflammation are further periodontal destruction and alveolar bone loss. Furthermore, these complications may be aggravated by the amalgam's susceptibility to tarnishing and corrosion and by the longer service life of over-hanged class II amalgam restorations, which instigate further plaque accumulation.

Scant information is available on the influence of the different service lives of class II amalgam restorations on the periodontal health among type 2 diabetes patients. Therefore, the present study was undertaken to assess certain periodontal parameters, such as plaque index (PI), gingival index (GI), and alveolar bone loss (ABL), among diabetic patients who had class II amalgam restorations for different service lives. The prevalence of class II overhanging restorations among the examined groups was also evaluated and compared.

The following hypotheses were tested in the current study: (1) whether the longer service life (age) of class II amalgam restorations will be accompanied by worse periodontal parameters, (2) whether the periodontal parameters are worse among groups with a higher prevalence of overhanging restorations, (3) whether the worst periodontal parameters will be found among groups with longer durations of diabetes mellitus along with longer service lives of class II amalgam restorations.

Materials and Methods

This research project was approved by the Research and Ethics Committee No. 002/18, January 1, 2018, of the Faculty of Dentistry, Najran University, Kingdom of Saudi Arabia. All clinical examinations and/or evaluations performed in the current study that involved human participants were in accordance with the ethical standards of the institutional and/or national research committee as well as the Helsinki declaration, as amended by the 64th WMA General Assembly, Fortaleza, Brazil, October 2013, and its later amendments or comparable ethical standards. In addition, signed consent forms were obtained from all examined patients who participated in the current study, prior to its commencement.

Sample size and sampling

The formula proposed by Crano and Brewer (2002) [26] for calculating the sample size in medical research was adopted in the current study to calculate the sample size as follows:

$$n = Nn^*/N+n^*$$

Where, n is the required sample size, N is the population size (the total number of participants, 638), and n* is the first estimated sample. The first estimated sample (n*) was determined using the following formula:

$$n^* = P\,(1-P)/(SE)^2$$

Where, P is the estimated proportion to participants, which was assumed to be 0.5 for getting the maximum sample size. SE is the standard error, assumed to be 0.05. Therefore, n*=100; consequently, the sample size (n) is 86.4. It should be noted that any further increment in the population size would have a limited effect on the results [26].

Inclusion and exclusion criteria

The inclusion and exclusion criteria for the selection of the participants adopted in the current study were as follows:

Inclusion criteria: The inclusion criteria included (1) medically diagnosed type 2 diabetes mellitus ≥ 2 years, (2) 45-60 years of age, (3) HbA1c levels ≥ 6.5% [Ref], (4) a minimum of 15 teeth remaining, and (5) one or more than one class II amalgam restorations; age ≥ 2 years.

Exclusion criteria: The exclusion criteria included (1) self-reported medical chronic conditions, such as HIV, cardiovascular complications, hepatic disorder, renal disorders, or epilepsy, (2) a history of previous antibiotic use or steroid therapy for the past three weeks, (3) immunosuppressive chemotherapy, (4) periodontal treatment for the past six months, (5) edentulous patients, and (6) crowding teeth or occlusal trauma.

Study population

In this observational comparative cross-sectional study, we selected 225 patients with type 2 diabetes from a sample of 638 patients who visited the specialized dental clinics of the Faculty of Dentistry, Najran University, Kingdom of Saudi Arabia. These patients were divided into five groups (G1-G5) according to the service life of their class II amalgam restorations. Each group comprised 45 patients aged 45-60 years. The service lives of the examined groups (G1-G5) were approximately 2, 4, 7, 10, and 12.5 years, respectively. It is worth noting that female subjects were not included in the current study because the dentistry program of the University of Najran admits only male students. Therefore, the study sample included only men.

Clinical examinations

All participants of the study underwent clinical oral examination, which included examining the status of periodontal tissues. As this was an observational comparative cross-sectional study, the clinical examination of the subjects was conducted using their current dental status. Moreover, no dental treatment was provided to the subjects prior to the clinical examination. The clinical screening involved evaluating the state of periodontal tissues by assessing the amount of dental plaque, PI, and gingival condition as well as the qualitative alterations of the gingiva, GI, using the two scoring systems: (1) the system proposed by Silness J and Löe H [27] for PI and (2) the system proposed by Löe H and Silness J [28] for GI. For the PI evaluation, four sides per tooth (buccal, lingual, mesial, and distal) were examined for each participant (except for the third molars) using William's periodontal probe. For the assessment of GI, certain teeth were chosen: 16, 12, 24, 32, 36, and 44.

Two periodontal investigators collected the periodontal parameters PI and GI. The values obtained were compared, and the overall kappa score for intraexaminer reliability was calculated.

Hemoglobin A1c level assessment

All participants of the examined groups were assessed for their current glycemic status. The medical records of the chosen participants were used to obtain the latest HbA1c levels (within one month), and new tests were performed on all participants. A comparison between the old medical records' registered results and the new results was performed to ensure consistency. An HbA1c analyzer kit (quo-Test, EKF Diagnostics, Magdeburg, Germany) was used to perform the chair-side glycemic status tests. Based on the medical records, a history of chronic medical illnesses, medical complications, and duration of diabetes mellitus of the examined groups were noted.

Radiographic procedure

Panoramic X-ray radiography was used to measure ABL and locate the sites of overhanging restorations. A panoramic X-ray unit (Planmeca Promax, Dent-R100, Helsinki, Finland) was used to produce the corresponding images. The desired resolution of each radiographic procedure was selected, followed by adjusting the height of the X-ray based on patient height. The patient's chin was placed on a chin cup, and the occlusal plane was set to horizontal. The patient was directed to grasp the handles for tightening the head support. The laser position was adjusted to correspond to the illustration on the touch screen. The final fine adjustments were made to the volume location when needed. We used a computer-assisted system to digitize and analyze all panoramic radiographs for linear measurements.

The panoramic radiographs and ABL measurements for all participants were taken during regular daily dental practice visits between March 2018 and February 2020.

Panoramic radiographs: A total of 45 complete sets of panoramic radiographs were obtained from the 45 participants of each of the examined groups, G1-G5; thus, the total number of all panoramic radiographs obtained amounted to 225. Each panoramic radiograph was examined. Therefore, 45 interproximal sites, of each group, toward the restored proximal site of the class II amalgam restorations were selected for measuring the mean ABL. Among the treated posterior teeth, we considered the mean ABL along with the overhanging restorations of class II amalgam restorations, irrespective of their class (premolars or molars), site (upper or lower), or side (mesial or distal).

The criteria for the acceptability of the panoramic radiographs were as follows: (1) clear visibility of the anatomical features, such as the cementoenamel junction (CEJ), alveolar bone crest (ABC), and tooth apices (AP); (2) CEJs were not compromised by the presence of a restoration, prostheses, traversing images, or defective radiographic image; and (3) both proximal sites (mesial and distal) were measurable. At the end of the selection process for the set of images, we discarded the radiographic images that did not meet the criteria. A computer screen was utilized to amplify and visualize the images.

The distances between the CEJ and the crest of the alveolar bone and between the crest of the alveolar bone and tooth apex were used to identify the alveolar bone with bone loss. ABL was defined as a distance of >2 mm between the CEJ and the ABC. The ABL was calculated as the percentage of bone loss [29], and the percentage of bone loss was calculated using the following formula [29]:

$$\frac{(CEJ-ABC)-2mm}{(CEJ-AP)-2mm}x100$$

All clinical data were collected by two periodontal investigators, and the collected data were grouped using Excel spreadsheets to record the percentage of alveolar bone level, root length, and bone loss in millimeters. The assessments of the ABL produced by the two investigators were compared, and the overall kappa score for intraexaminer reliability was calculated.

Statistical analysis

The data were statistically evaluated using IBM SPSS version 25. The variables were expressed as mean ± SD and analyzed by means of the Scheffé test and one-way analysis of variance (ANOVA). A p-value <0.05 was considered statistically significant, and a p-value <0.0001 was deemed extremely significant.

Results

The mean ages of the participants in groups G1-G5 were 53.2 (SD 3.6), 50 (SD 4.9), 54 (SD 3.7), 59 (SD 4.2), and 60 (SD 3.9) years, respectively (Table 1). The participants in G4 and G5 were significantly older than those in G1-G3 (p=0.03), with no significant difference between them (p=0.392). The G2 participants were the youngest; however, this result is statistically of a marginal difference. There was no significant difference in the mean ages of G1 and G3 participants, (p=0.392).

Table 1 lists the glycemic status and diabetes durations of all examined groups. HbA1c (± SD) mean levels of the participants in G1-G5 were 7.8 (SD 0.38), 8.4 (SD 0.9), 9 (SD 1.14), 9.8 (SD 0.95), and 11 (SD 0.93), respectively. The mean duration of diabetes mellitus (± SD) for the same groups were 2.1 (SD 0.33), 4.3 (SD 0.36), 5.8 (SD 1.2), 12.5 (0.9), and 12 (SD 0.84), respectively. The ANOVA test showed that the diabetes durations of G1-G3differed significantly (p<0.001), whereas G4 and G5 exhibited no significant difference in their diabetes durations (P=0.41); however, both had significantly longer durations than the other groups (p<0.001).

The mean ages of the class II amalgam restorations in the patients in G1-G5 were 2.2 (SD 0.35), 4.3 (SD 0.4), 7 (SD 0.65), 10.2 (0.8), and 12.1 (0.65) years, respectively (Table 2). Furthermore, statistical analysis showed that these service life durations significantly differed (p<0.001). With regard to the overhangs of the class II amalgam restorations, the chi-square test showed that class II amalgam restorations among G1 had a significantly higher rate of overhanging restorations (62.2%) than those of the other groups (p<0.001). There was no significant difference in the percentage of overhangs between

Table 1: Mean age of patients with diabetes (Y), HbA1c, and duration of diabetes (Y).

Group	Total No. of class II amalgam restorations	Mean age of class II amalgam restorations (SD)	Total No. of overhanging restorations	Prevalence of overhanging restorations %
G1	45	2.2 (0.35)	28	62.2
G2	45	4.3 (0.4)	22	48.8
G3	45	7 (0.65)	24	53.3
G4	45	10.2 (0.8)	21	46.6
G5	45	12.1 (0.65)	25	55.5

Table 2: Total No. of class II amalgam restorations, mean age of class II amalgam restorations, and prevalence of overhanging restorations among the examined groups.

Group	No. of subjects	Mean age of subjects (years) (SD)	Mean HbA1c (SD)	Mean Duration of Diabetes (years) (SD)
G1	45	53 (3.6)	7.8 (0.83)	2.1 (0.33)
G2	45	50 (4.9)	8.4 (0.9)	4.3 (0.36)
G3	45	54 (3.7)	9 (1.14)	5.8 (1.2)
G4	45	59 (4.2)	9.8 (0.95)	12.5 (0.9)
G5	45	60 (3.9)	11 (0.93)	12 (0.84)

G2 and G4 (p=0.23) or between G3 and G5 (p<0.25). The overhangs' rates among the examined groups are listed in table 2.

The mean values of the PI and GI scores and the standard deviation of all examined groups are listed in table 3. The mean values of these indices for G1-G5 were 2.2 and 1.8 (SD 0.35, 0.2), 2.35 and 2.1 (SD 0.26, 0.3), 2.45 and 2.25 (SD 0.32, 0.3), 2.8 and 2.65 (SD 0.29, 0.33), and 2.9 and 2.8 (SD 0.24, 0.24) respectively. No statistically significant difference in the two values was observed between G1 and G2 (p=0.42). G3 had significantly higher values than those of G1 and G2 (p<0.001). Statistically, G4 and G5 had the highest two values of all groups (p<0.001).

A comparison of the assessments made by the two investigators produced an overall kappa score of 0.93 for intraexaminer reliability, suggesting a good agreement between the two investigators.

Table 3 lists the results of the ABL and the standard deviation for all examined groups. The mean percentages of the ABL (± SD) recorded in G1-G5 were 42% (SD 4%), 45.5% (SD 2.9%), 48% (SD5.9%), 57% (SD 4.6%), and 59.5% (SD 6.2), respectively. ANOVA revealed that patients in G4 and G5 demonstrated the highest mean percentage of ABL among the examined groups (p<0.001), with no significant difference between them (p=0.329). The smallest amount of ABL among all examined groups was observed in G1 (p<0.001). Furthermore, there was no significant difference in the amount of ABL between G2 and G3 (p<0.001), which demonstrated intermediate ABL values between the lowest ABL recorded by G1 and the highest recorded ABL by G4 and G5.

A comparison of the assessments made by the two investigators produced an overall kappa score of 0.90 for intraexaminer reliability, suggesting a good agreement between the two investigators.

Figures 1-5 shows representative alveolar bone loss images for all examined groups.

Discussion

The results of the current study showed that the periodontal parameters (PI, GI, ABL) of the examined groups G2-G5 were worse compared with those of G1. Moreover, the high ABL among the participants of these groups suggested severe periodontal destruction, caused by severe chronic periodontitis, whereas the lower ABL among the participants of G1 may indicate that the periodontal inflammation caused by moderate chronic periodontitis was less severe. There are several risk factors that are considered to be pertinent in causing the outcomes observed in the examined groups regarding periodontal parameters. These are as follows: (1) dental plaque, (2) age of subjects, (3) age of class II amalgam restorations, (5) prevalence of class II amalgam restorations' overhangs, and (6) hyperglycemia status, control level, and duration.

Table 3: Mean plaque index, mean gingival index, and mean alveolar bone loss among the examined groups.

Group	Mean plaque index (SD)	Mean gingival index (SD)	Mean alveolar bone loss (SD) %
G1	2.2 (0.35)	1.8 (0.26)	42 (4)
G2	2.35 (0.26)	2.1 (0.3)	45.5 (2.9)
G3	2.45 (0.32)	2.25 (0.3)	48 (5.9)
G4	2.8 (0.29)	2.65 (0.33)	57 (4.6)
G5	2.9 (0.24)	2.8 (0.24)	59.5 (6.2)

Figure 1: Diabetic patient treated with class II amalgam restoration; the age of restoration is 2 years, and the alveolar bone loss area is indicated by an arrow in the interproximal area between 16 and 17.

Figure 2: Diabetic patient treated with class II amalgam restoration; the age of restoration is 4 years, and the alveolar bone loss area is indicated by an arrow in the interproximal area between 16 and 17.

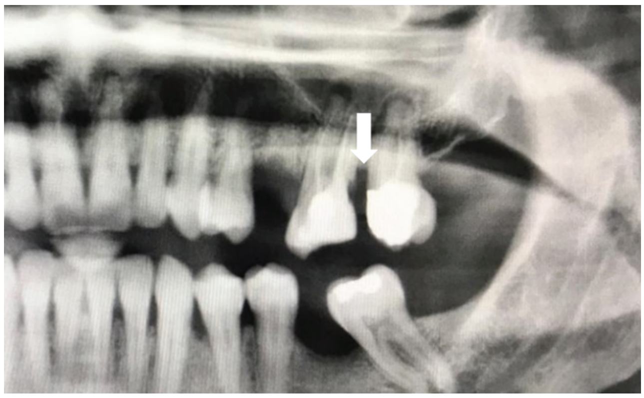

Figure 3: Diabetic patient treated with class II amalgam restoration; the age of restoration is 7 years, and the alveolar bone loss area is indicated by an arrow in the interproximal area between 26 and 27.

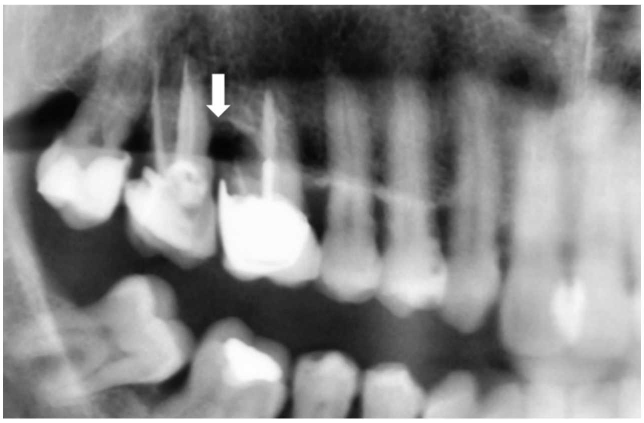

Figure 4: Diabetic patient treated with class II amalgam restoration; the age of restoration is 10 years, and the alveolar bone loss area is indicated by an arrow in the interproximal area between 16 and 17.

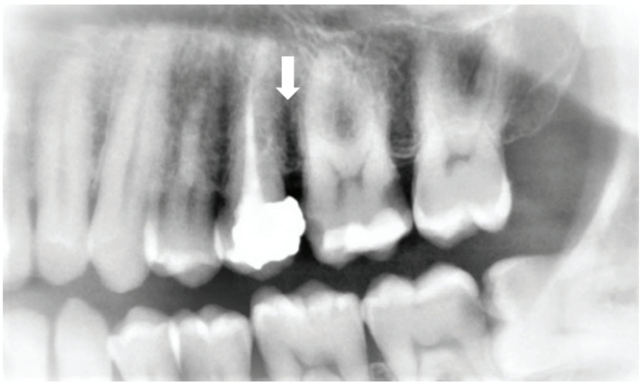

Figure 5: Diabetic patient treated with class II amalgam restoration; the age of restoration is 12.1 years, and the alveolar bone loss area is indicated by an arrow in the interproximal area between 25 and 26.

With respect to hyperglycemia, two combined risk factors should be considered when evaluating the periodontal health status of patients with diabetes: (1) glycemic status, represented by HbA1c, and (2) duration of diabetes. As anticipated, the HbA1c levels of the examined groups were considerably high in the current study. Moreover, there was a successive increase in the periodontal scores with a longer duration of hyperglycemia among groups. For example, the shortest duration, 2.1 years, among the participants of G1, was accompanied by the lowest periodontal scores. Then these scores steadily escalated with longer durations, for 4.3, 5.8, 12, and 12.5 years, for G2-G5, respectively. These results, along with prior reports documented in the literature [16-21], reaffirm that hyperglycemia is an influential risk factor for periodontal inflammation and the subsequent worse periodontal parameters. Moreover, owing to the fact that hyperglycemia is significantly associated with worse periodontal parameters, it should be noted that a longer duration of an uncontrolled glycemic status can be more destructive to periodontal tissues than a merely high HbA1c level. The worst periodontal parameters of the examined groups of the current study were observed among participants with longer diabetes duration, i.e., >5 years, G3-G5; this was in accordance with previous results found in the literature. A study by Al-Shammari KF, et al. [21] reported that patients with a longer duration of diabetes (≥ 5 years) had worse periodontal parameters when compared with patients with a shorter duration (<5 years). The effect of diabetes and prediabetes on the periodontal parameters was evaluated by Abduljabbar T, et al. [17], who reported worse periodontal parameters among diabetic and prediabetic patients when compared with their non-diabetic control. They also stated that the severity of periodontal inflammation is significantly dictated by the duration of hyperglycemia [17]. Thus, it is possible to infer that periodontal health in patients with diabetes is negatively influenced not only by poor glycemic control but also, more crucially, by the duration of hyperglycemia. However, it should be noted that this impact may occur with significant heterogeneity due to the involvement of other possible risk factors [30], such as poor oral hygiene, faulty dental restorations, tobacco smoking, hypertension, and older age.

In the current study, the periodontal parameters of the examined groups were in accordance with the different service lives of class II amalgam restorations. There appeared to be further ABL with the longer service life of class II amalgam restorations, which indicated a direct association between the service life of class II amalgam restoration and the ABL. For instance, for ≈ 2 years of class II amalgam restorations in service, G1 recorded the lowest amount of ABL as well as the lowest PI and GI scores. Meanwhile, the ABL then increased steadily along with the PI and GI for G2-G5, with the passage of time (longer service of class amalgam restorations) in G2 (four years) and in G3 (seven years). The highest amount of ABL, which exceeded 50%, as well as the highest PI and GI scores were recorded in G4 and G5 for 10.2 and 12.1 years of class II amalgam restoration service life, respectively. Accordingly, these outcomes support the first hypothesis that states longer service life (age) of class II amalgam restorations will be accompanied by worse periodontal parameters. Furthermore, since the worst periodontal parameters were found among patients with longer service life class II amalgam restorations along with longer diabetes duration, the third hypothesis is also accepted.

The prevalence of overhanging restorations among the examined groups (G1-G5) ranged from 46.6% to 62.2%. The highest incidence of overhanging restorations, found among the subjects of G1, was accompanied by the lowest amount of ABL as well as the lowest PI and GI scores. G2 and G4 had similar rates of overhangs; however, they showed significantly different periodontal parameters outcomes. The same pattern occurred in G3 and G5, where their similar rates of overhangs did not entail similar periodontal scores. These results indicated that the overhang's incidence among the examined groups did not correlate with their periodontal parameters' scores. The interpretation that can be posed in this respect is related to the size of class II amalgam restoration and/or the size of the overhang's margins. Nevertheless, the two factors are beyond the scope of the present investigation. It is well established that an overhanging margin less than 0.2 mm should be harmless to periodontal health [31-33]. It is worth noting that the periodontal parameters of all examined groups significantly correlated with the service life of class II amalgam restorations but not with the incidence of overhanging restorations. Therefore, it can be speculated that the longer service life (age) of overhanging restoration is more detrimental to periodontal health than merely the prevalence of overhanging restorations. Thus, the second hypothesis that states the periodontal parameters are worse among groups with a higher prevalence of overhanging restorations is rejected.

It is a well-known and an accepted fact that aging increases the susceptibility to chronic inflammatory diseases and microbial infections [34]. The examined groups showed a significant association between age and periodontal health. The G1 (the group with the youngest subjects) had relatively better periodontal health than those of G2-G5, as shown by their moderate periodontal parameters scores, ABL, PI, and GI. This was followed by the worse periodontal parameters for the subjects of G2 and G3, who had higher scores than those of G1. The worst periodontal parameters were equally observed among G4 and G5 (the groups with the oldest subjects). Despite these results, which indicate a significant association between age and the periodontal status, the important role of the other risk factors, such as diabetes mellitus and the age of class II amalgam restorations, should not be overlooked. The results of the current study indicated that these risk factors, along with age, must have dictated the periodontal health among these groups.

In fact, epidemiological investigations have constantly indicated that diabetes mellitus is a major risk factor for periodontitis, especially among individuals with poor glycemic control [35-39]. It has been speculated that hyperglycemia instigates the growth and accumulation of advanced glycemia end product (AGE) [40]. The interaction taking place between these end products and their receptors (RAGEs) in the periodontal complication site is responsible for inducing proinflammatory cytokines that promote periodontal inflammation and degradation of alveolar bone [41,42]. In fact, the risk of experiencing severe periodontitis is two or three times greater for diabetes patients than for those without diabetes [43]. The advent of the impact of diabetes as a major reason for advanced periodontal complications, such as periodontitis, was reported by many retrospective studies. For instance, Emrich LJ, et al. [44] evaluated the severity of periodontal disease and its associated complications in the Pima Indian population, which has the most prevailing type 2 diabetes in the world. They found that individuals with diabetes are three times more likely to develop severe periodontal disease. In another research study conducted by Nelson RG, et al. [45], it was reported that diabetes patients faced a 2.6 times greater risk of periodontal disease compared to patients without diabetes. Taylor GW, et al. [46] stated that subjects with type 2 diabetes had a four gold greater risk for a more severe alveolar bone loss progression. A few previous studies have shown that poor glycemic control can synergistically act with other risk factors, such as poor oral hygiene, which aggravates the situations and causes even further periodontal destructions [47-49]. Moreover, Tanweer F, et al. [43], investigated the effect of diabetes on the periodontal status of a population with poor oral hygiene. The examined subjects had high PI and GI scores as well as a clinical attachment loss. This study concluded that there was a higher prevalence of moderate to severe periodontitis among the examined subjects. A meta-analysis investigation carried out by Khader YS, et al. [50], has shown that patients with type 2 diabetes had poor oral hygiene, higher severity of gingival inflammation, and higher severity of the periodontal disease. Furthermore, Preshaw PM, et al. [51] stated, in a review study, that diabetes and severe periodontitis caused massive alveolar bone loss among the examined subjects. This extensive alveolar bone loss was found to affect the entire dentition, reaching up to 50% to 75% of the total root length. The worst periodontal status and metabolic condition were found among patients with both periodontitis and diabetes mellitus. These studies pointed toward the direct association between diabetes and worse periodontal health. However, there were no studies in the literature that evaluated this association with the presence of different dental restorations, such as class II amalgam restoration and the subsequent periodontal health. Hence, it was difficult to compare the current findings with previously published data.

One limitation of the current study is the lack of accurate data regarding the manner in which the diabetes was controlled (treatment) for the examined groups. Many researchers found that patients with difficulty controlling their serum glucose level are more prone to periodontal complications [51,52]. Some other limitations may also have caused the outcomes of the present study to be biased. Females were not included in this study, but hormonal changes in females have been shown to increase the likelihood of periodontal inflammation [53]. Despite the fact that males have a higher rate of periodontal disease, more research assessing the severity of periodontal disease and consequent alveolar bone loss between females and males is still needed. Moreover, the obesity status with respect to chronic diseases (systemic factors) was not assessed. Obesity is a well-known risk factor for periodontal disease and can be associated with poor periodontal parameters [54]. The patient's smoking status is another limitation of this study. Smoking is a major risk factor for many medical problems, and periodontal health is not an exception [55]. Some limitations related to class II amalgam restorations, such as the smoothness of class II restorations and the size of proximal overhangs should not be overlooked. Thus, it is necessary to initiate further research that considers the different aspects of these limitations.

Conclusion

The present study has shown that patients with diabetes exhibit a wide range of values for the examined periodontal parameters (PI, GI, ABL). Furthermore, this study highlights the various aspects of the relationships between the service life of class II amalgam restoration, age of subjects, overhanging restorations, diabetes mellitus, and periodontal health.

A high incidence of overhanging restorations, as in the case of some diabetes groups (second hypothesis), does not necessarily entail worse periodontal parameters, as originally anticipated. Other factors such as the service life of class II amalgam restoration, age of subjects, size of overhangs' margins, and diabetes mellitus should also be considered. More specifically, a single risk factor may not be solely responsible for worse periodontal parameters. The synergistic action of multiple risk factors is expected to result in significant periodontal destruction and the subsequent deterioration of periodontal parameters. However, since the diabetes mellitus status and duration, the service life of class II amalgam restorations, and age of subjects consistently correlated with the worse periodontal parameters in the current study, it can be assumed that these risk factors were the most influential ones for the worse periodontal parameters among the examined subjects.

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Author Contribution

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

Conflict of Interest

The author declares that the work documented in this scientific article is not recognized for any conflicting financial interests and/or personal connections.

Data Availability Statement

The datasets used or analyzed during the present investigation are available from the corresponding author on request.

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