

The Effect of Resin Composites and Polishing Procedure on Periodontal Tissue Parameters in Patients with Diabetes Mellitus

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Abstract - *The aim of this study was to establish relationship between restorative resin and periodontal tissues of patients with diabetes mellitus. We selected 30 patients, 15 patients with diabetes mellitus with a total of 30 restorations and 15 patients without diabetes mellitus with a total of 49 restorations and the periodontal parameters and restorations parameters were evaluated. The total period was 12 months. The results showed a significant improvement in periodontal parameters assessed ($p < 0.05$). It may be concluded that over the 12-month period, there was no adverse reaction to periodontal tissue as a result of various polishing regimes of a restorative resin-based composite in patients with diabetes mellitus.*

KEY WORDS: Diabetes mellitus, resin composite, periodontal disease, biocompatibility, clinical attachment, inflammation

INTRODUCTION

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from the failure of insulin secretion or action, and it is considered a risk factor for periodontal disease. This occurs due to the number of changes in the cells and molecules of patients with periodontitis as a result of hyperglycemia. Thus, the prevalence of periodontitis in adolescents and young adults with diabetes has been found to be significantly higher than in non-diabetic subjects¹.

Periodontal disease is considered the sixth classical complication of diabetes mellitus. There is an association between diabetes mellitus and periodontal disease, in which diabetes favors the development of periodontal disease which, if left untreated, hinders the metabolic control of diabetes. Periodontitis related to systemic diseases is caused by bacterial plaque and exacerbated by the patient's systemic condition². In addition to its deleterious effect on oral health and glycemic control, several studies have shown the association of periodontal disease with coronary disease, another important cause of morbidity and mortality in diabetics³.

The presence of restorations close to the gingival tissues may cause biological changes in periodontal tissues. Thus, the marginal adaptation, crown contour and surface finishing of restorations should be adequate to maintain the health and position of gingival tissues. Maladapted restorations with excessively large filling margins or lack-

ing contour, with rough or porous surfaces, can lead to inflammation, excessive growth or retraction of the gingival tissues⁴. Therefore, the presence of inadequate restorations or those with materials that are not very smooth may contribute to bacterial plaque accumulation and consequently, the appearance of periodontitis⁵.

In order to facilitate the process of finishing, polishing and improving the smoothness of restoration margins close to the cervical margin, a one-step finishing and polishing system was recently developed. In this system, the anatomical contouring, finishing and polishing procedures are performed with the same instrument⁶. It has been reported that the single-step systems were superior, or at least comparable with the traditional multiple-step techniques⁷.

The aim of this study was to establish the relationship between the health of periodontal tissues and restorative resin containing nanoparticles, with the use of different types of polishing in anterior and posterior teeth with non-carious cervical lesions in patients with diabetes mellitus and periodontal diseases.

MATERIALS AND METHODS

Thirty patients were selected, 12 men (5 diabetic and 7 non-diabetic) and 18 women (10 diabetic and 8 non-diabetic), aged from 18 to 70 years. There were 15 patients with diabetes mellitus with a total of 30 restorations and 15 patients without diabetes mellitus with a total of 49 restorations. These patients had abfraction lesions in the cervical regions of anterior and posterior teeth (incisors, canines and/or premolars). The inclusion criteria were as follows: patients with teeth in normal position in both arches, with clinical examination performed on the buccal, lingual/palatal, mesial and distal surfaces, teeth with cervical abfraction lesions in the same arch (maxilla or

* DDS

mandible), as well as exclusively plaque-induced gingivitis, thus demonstrating difficulty with cleaning in the area to be restored. As regards the exclusion criteria, the non-diabetic patients had to be free of any other systemic compromise. In addition, the following patients were excluded from the study: the patients should present a positive history of antibiotic therapy within the last six months and use of steroidal or non-steroidal anti-inflammatory drugs three months prior to the study; positive history of pregnancy; positive history of contraceptive use or any other type of hormone therapy; positive history of smoking; positive history of periodontal treatment within the last 12 months.

Table 1. Composition of materials used.

<i>Materials</i>	<i>Composition</i>	<i>Manufacturer</i>
Filtek Z350	Organic matrix: BisGMA, BisEMA Inorganic matrix: Zirconia-silica - 0.6 to 1.4 µm, SiO ₂ nanoparticles - 20nm	3M ESPE
Single Bond	BisGMA, HEMA, dimethacrylates, ethanol, water, a photoinitiator system and an innovative methacrylate-functional copolymer polyacrylic and polyalkenoic acids	3M ESPE
Soft-Lex	Al ₂ O ₃ grain sizes: Coarse - 92-98 µm Medium - 25-29 µm Fine - 16-21 µm Extra fine - 2-5 µm	3M ESPE
PoGo	Polyurethane dimethacrylate, camphorquinone, N-methyl diethanolamine, micro-particles of diamond and aluminum oxide. Grain size of 7 µm.	Dentsply
Flexi Cups	Al ₂ O ₃ grain sizes: Medium (blue) Extra-fine (pink)	Cosmedent

The study was submitted to the Research Ethics Committee of the West Paraná State University and it was approved in compliance with the fundamental requirements of the National Health Council Resolution 196/96 (Brazil) and its complements.

Clinical Evaluation

Initial clinical exam was performed by a single previously trained examiner, who used a No. 23 periodontal probe of the Williams type, and determined:

1. Silness & Løe plaque index⁸; consisting of the absence or presence of visible plaque located on the each tooth surface, divided into four zones: buccal, distal, mesial, and lingual/palatal.
2. Løe & Silness gingival index⁹. representing dichotomization of the presence or absence of bleeding, in the same zones previously mentioned.
3. Probing depth: distance from the bottom of the sulcus to the gingival margin at six points: mesio-buccal, buccal, disto-buccal, disto-lingual/palatal, lingual/palatal and mesio-lingual/palatal of each tooth examined.
4. Clinical attachment level: also determined at the same six points as for the probing depth.
5. Bleeding on probing.

After the initial clinical examination, all patients underwent basic periodontal therapy and the teeth with non-carious cervical lesions were restored. The patients were randomly divided into 2 groups with 15 patients each.

Therefore, each group was provided with instructions for correct mechanical plaque control, which were the same for all groups, and supportive periodontal therapy. The next step was to restore the non-carious cervical lesions using nanoparticle resin composite Filtek Z350 (3M ESPE - Ribeirão Preto - São Paulo - Brazil) and conventional two-stage adhesive system (Single Bond/3M ESPE - Ribeirão

Table 2. USPHS evaluation criteria for direct clinical evaluation of restorations.

<i>Category</i>	<i>Evaluation scale</i>		<i>Criterion</i>
	<i>Acceptable</i>	<i>Inacceptable</i>	
Marginal adaptation	A B	C	Undetectable by probing Detectable gap (exploratory probe holds on both sides) Obvious gap or fracture
Anatomical shape	A B	C	Undetectable gap Detectable gap only in enamel Detectable gap involving enamel-dentin
Marginal discoloration	A B	C	No discoloration Surface stain (removable, usually localized) Deep stain
Caries formation	A	B	No evidence of caries Evidence of caries
Postoperative sensitivity	A	B	Absence of postoperative sensitivity Experience of postoperative sensitivity sometime in the restorative process or during the period of the study
Retention	A B	C	Retained Partially retained Loss of restoration

Preto - São Paulo - Brazil). The composition of the adhesive system and resin composite used is shown in Table 1. All restorations were performed by the same previously calibrated operator.

Each patient received at least one restoration for each polishing group studied. The size of the lesions restored ranged from superficial lesions (less than 1 mm deep), often presenting sensitivity to cold and hot temperatures or to jets of air, to large lesions of approximately 5 mm in the occlusogingival direction and approximately 2 to 3 mm deep.

The lesions were restored by a single operator and the restorations were performed in accordance with the manufacturer's instructions, as follows: previous prophylaxis with a rubber cup and pumice stone paste and water; color selection; a 2-mm long bevel was placed on the enamel margin; absolute isolation; prophylaxis with pumice and water, acid etching of dentin (15 sec) and enamel (30 sec); washing and drying; application of the adhesive system according to the manufacturer's instructions; photoactivation for 20 seconds (Free Light/3M ESPE with 900 mW/cm² - Ribeirão Preto - São Paulo - Brazil); application of resin composite using the incremental insertion technique and photoactivation for 30 seconds on each increment. The resin composite excesses were removed using an extra fine diamond tip (KG Sorensen 1111 FF - Barueri - São Paulo - Brazil) at high speed under abundant cooling. Finishing and polishing of the restorations was performed after seven days and the work was divided into three subgroups: G1 - Soft-Lex disks (3M ESPE - Ribeirão Preto - São Paulo - Brazil), G2 - Flexi Cup abrasive tips (Cosmedent - Curitiba - Paraná - Brazil) and G3 - PoGo abrasive rubbers (Dentsply- Petrópolis - Rio de Janeiro - Brazil). In subgroup G1, the restorations were polished with disks impregnated with aluminum oxide in decreasing grain size (Soft-Lex/3M ESPE) with intermittent pressure and at low speed for 20 seconds. Before each change of disk, the restorations were washed with jets of air/water to remove polishing residues, dried with air jets, and then polished with another disk of finer-grain size. For subgroup G2, the restorations were polished with abrasive tips (Flexi Cups/Cosmedent) applying the blue tip first for 40 seconds, followed by jets of water to remove polishing residues, dried with air jets, and then polished with the pink tip for 40 seconds. For subgroup G3, the restorations were polished with the PoGo system using a diamond disk for 30 seconds.

A periodontal evaluation of the teeth restored was performed after 1 and 12 months by a single previously calibrated examiner, who reevaluated the same indexes as those previously described. The same teeth also were also evaluated after 1 and 12 months to assess the restorations using the same evaluation criteria described in Table 2.

RESULTS

Table 3 shows the mean values, in millimeters, of Probing Depth, clinical attachment level, gingival index, bleeding on probing and plaque index in both groups and polishes at the time intervals of 0, 1 and 12 months, respectively. With respect to all the periodontal evaluation criteria in the diabetic group, maintenance therapies were performed and statistically significant differences ($p < 0.05$) were found between the initial and final time intervals with a moderate

improvement in the parameters analyzed. As regards the periodontal evaluation criteria in the non-diabetic group, maintenance therapies were performed and statistically significant differences ($p < 0.05$) were found between the initial and final time intervals with significant improvement in most of the criteria.

Table 4 shows the mean percentages of marginal adaptation, anatomical shape, marginal discoloration, formation of caries, postoperative sensitivity, and retention of both groups, with polishing at 0, 1 and 12 months, respectively. With regard to the diabetic and non-diabetic groups with non-carious cervical lesions that were polished with Soft-Lex Cosmedent and PoGo, the Fisher's exact test and Chi-Square tests showed no statistically significant differences ($p > 0.05$) for the criteria *marginal adaptation*, *marginal discoloration*, and *anatomical shape*, between the initial time interval and the time intervals of 1 month and 12 months.

For the diabetic and non-diabetic groups with non-carious cervical lesions that were polished with Soft-Lex Cosmedent and PoGo, the Fisher's exact test and the Chi-Square test showed no statistically significant differences ($p > 0.05$) for the criteria *caries formation*, *postoperative sensitivity*, and *retention*, between the initial time interval and the time intervals of 1 and 12 months.

DISCUSSION

There is an intimate and inseparable relationship between periodontal health and the restoration of teeth. To ensure that restorations last for long periods, the periodontium must remain healthy in order to maintain the teeth. For the periodontium to remain healthy, restorations must be carefully adjusted in different areas to maintain harmony with the surrounding periodontal tissues⁴. However, the aim of the present study was to elucidate the long-term stability of restorative resins containing nanoparticles, used in patients with diabetes mellitus, and submitted to three types of polishing procedures.

The extensive literature on diabetes mellitus and periodontal disease, as well as the overall impression of clinicians, indicate that the periodontal disease in diabetic patients does not follow a consistent or distinct pattern. Severe gingival inflammation, deep periodontal pockets, rapid bone loss and periodontal abscesses frequently occur in diabetic patients with poor oral hygiene¹⁰. There is no significant difference between the microbiota in diabetic and non-diabetic patients. This suggests that the greater prevalence, extent and severity of destructive periodontal disease in these individuals must be attributed to changes in the host immune response¹¹. Therefore, oral hygiene instruction is a key-factor in treatment planning for diabetic or non-diabetic patients with periodontal disease and part of the follow-up maintenance treatment program¹².

In this study, clinical variations among probing depth, clinical attachment level, plaque index, gingival index and bleeding on probing were observed after 12 months in Groups 1 and 2, who had undergone the same basic periodontal therapy, restorative and polishing procedures, and statistically significant differences were found ($p < 0.05$), as shown in Table 3, although the clinical differences were not extremely significant. The nanoparticle resin composites

Table 3. Mean \pm standard deviation of Probing Depth, clinical attachment level, gingival index, bleeding on probing, and plaque index during the maintenance therapies at time intervals of 0, 1 and 12 months.

	Groups	Time intervals	Polishing		
			Flexi Cups	PoGo	Soft-Lex
Probing depth (mm)	Diabetics	Initial	1.978 \pm 0.49A	1.761 \pm 0.35D	1.849 \pm 0.41E
		1 month	1.949 \pm 0.48B	1.746 \pm 0.39F	1.889 \pm 0.40G
		12 months	1.937 \pm 0.88C	1.759 \pm 0.72D	1.733 \pm 0.66H
	Non-diabetics	Initial	2.254 \pm 0.78I	1.887 \pm 0.31G	2.330 \pm 0.51L
		1 month	2.125 \pm 0.78J	1.847 \pm 0.20E	2.582 \pm 0.46M
		12 months	2.056 \pm 1.14K	1.976 \pm 0.73N	1.979 \pm 0.63N
Clinical attachment level (mm)	Diabetics	Initial	2.397 \pm 0.23A	2.490 \pm 0.52D	2.799 \pm 1.03G
		1 month	2.460 \pm 0.51B	2.513 \pm 0.70E	2.810 \pm 1.05H
		12 months	1.907 \pm 1.13C	1.667 \pm 1.29F	1.521 \pm 1.41I
	Non-diabetics	Initial	2.398 \pm 1.12A	1.565 \pm 0.76L	1.522 \pm 0.47O
		1 month	2.421 \pm 1.01J	1.750 \pm 0.80M	1.762 \pm 0.41P
		12 months	2.156 \pm 1.20K	2.043 \pm 1.09N	1.839 \pm 0.78Q
Gingival Index (%)	Diabetics	Initial	0 \pm 0A	1.60 \pm 0.05B	1.60 \pm 0.05B
		1 month	0 \pm 0A	0 \pm 0A	0 \pm 0A
		12 months	0 \pm 0A	0 \pm 0A	0 \pm 0A
	Non-diabetics	Initial	0 \pm 0A	0 \pm 0A	3.30 \pm 0.06C
		1 month	0 \pm 0A	0 \pm 0A	1.60 \pm 0.05B
		12 months	0 \pm 0A	0 \pm 0A	0 \pm 0A
Bleeding on probing (%)	Diabetics	Initial	6.65 \pm 0.11A	9.99 \pm 0.16F	11.75 \pm 0.10B
		1 month	5.00 \pm 0.10C	6.63 \pm 0.80A	6.63 \pm 0.11A
		12 months	2.77 \pm 0.68E	4.77 \pm 0.90C	4.75 \pm 1.26C
	Non-diabetics	Initial	1.60 \pm 0.05G	11.64 \pm 0.13B	13.30 \pm 0.15
		1 month	0 \pm 0H	6.65 \pm 0.80A	8.24 \pm 0.14D
		12 months	8.85 \pm 0.95D	7.46 \pm 0.90I	4.53 \pm 0.37C
Plaque Index (%)	Diabetics	Initial	20.00 \pm 0.05A	40.00 \pm 0.11F	29.81 \pm 0.13B
		1 month	23.10 \pm 0.21C	31.61 \pm 0.38B	23.30 \pm 0.11C
		12 months	23.05 \pm 0.26C	10.71 \pm 0.12D	0 \pm 0G
	Non-diabetics	Initial	4.97 \pm 0.11E	3.32 \pm 0.06E	34.89 \pm 0.11H
		1 month	3.31 \pm 0.10E	5.00 \pm 0.21E	23.31 \pm 0.20C
		12 months	10.41 \pm 0.19D	14.23 \pm 0.20I	19.58 \pm 0.30A

*p<0.05 Different letters are statistically significant.

did not act as a factor that was clinically aggressive to the periodontal tissue in the two groups and the resin was shown to be clinically healthy in patients with diabetes mellitus, irrespective of the type of polishing performed and over a long period of time, corroborating the study of Nassar et. al.¹² who also found similar results over a short period of time.

Close to gingival tissues, restorations that lack contouring, particularly those that cannot be well polished and smoothed, can exacerbate the presence and accumulation of bacterial plaque in the oral cavity and consequently, cause the onset of periodontitis⁵. In addition, this may possibly exacerbate hyperlipidemia induced by diabetes, cause changes in immune cells, and decrease tissue repair capacity¹³.

Currently, from a periodontal point of view, the supragingival and gingival restoration margins are well tolerated, because restorations can easily be completed, with a smooth,

perfect and esthetically harmonious interface produced at the gingival margin⁴. Costa et al.¹⁴ and Gedik¹⁵ found that polishing provides greater tolerance of the restoration by periodontal tissue, and according to Chung et al.¹⁶, these procedures cause a decrease in roughness that ranges from 26 to 74%. Kawai & Urano¹⁷ reported the importance of a smooth surface to prevent bacterial plaque accumulation and its influence on the periodontal health of patients, even of those with good oral hygiene.

Several factors can determine the surface characteristics of resin composite restorations after the finishing and polishing techniques. This includes restorative material characteristics such as shape, hardness and size of filler particles and factors related to the abrasive systems of the polishing materials, such as flexibility of the material in which the abrasive is impregnated¹⁸. The results obtained in this study show that the nanoparticle resin composite used for restorations performed in diabetic and

Table 4. Means of percentages (%) of direct clinical evaluation of restorations in diabetic and non-diabetic groups, and their respective polishing and time intervals.

Criteria		Sof-lex						Flexi Cups						PoGo					
		Diabetics			Non-diabetics			Diabetics			Non-diabetics			Diabetics			Non-diabetics		
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Marginal adaptation	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
	1	90	10	0	100	0	0	100	0	0	100	0	0	100	0	0	90	10	0
	12	90	10	0	100	0	0	90	10	0	100	0	0	90	0	10	90	10	0
Anatomical shape	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
	1	90	10	0	100	0	0	80	20	0	100	0	0	100	0	0	100	0	0
	12	80	20	0	100	0	0	70	30	0	90	10	0	80	10	10	90	10	0
Marginal discoloration	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
	1	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
	12	90	10	0	90	10	0	80	20	0	90	10	0	90	0	10	100	0	0
Caries formation	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
	1	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
	12	100	0	0	100	0	0	100	0	0	100	0	0	90	10	0	100	0	0
Postoperative sensitivity	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
	1	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
	12	70	30	0	90	10	0	70	30	0	90	10	0	60	40	0	90	10	0
Retention	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
	1	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
	12	100	0	0	100	0	0	100	0	0	100	0	0	90	0	10	100	0	0
Reason for restorations	0																		
	1	80 (8/10)			100 (15/15)			80 (8/10)			100 (17/17)			80 (8/10)			100 (17/17)		
	12																		

*Non-significant statistical data within the same group with $p > 0.05$.

non-diabetic patients with non-carious cervical lesions, maintained their characteristics similar to those found at the initial time interval even after 12 months, as it can be seen in Table 3. All the criteria showed clinical variations between the initial and final time intervals, most notably the criterion for postoperative sensitivity. However, no statistically significant differences were found ($p > 0.05$) for these clinical parameters, thus favoring easy biofilm control in both group.

In this study Groups 1 and 2 received three types of polishing with Soft Lex disks (3M ESPE), Flexi Cup abrasive tips (Cosmedent), PoGo abrasive rubber (Dentsply). According to the results in Table 3, in spite of the three polishing procedures showing clinical differences between the initial and final time interval (12 months), no statistically significant differences were found in the clinical parameters between the two groups ($p > 0.05$). These results can be explained due to the characteristics of the restorative material, since the nanoparticle resin composite used in this study has filler particles that promote greater surface regularity and facilitate the polishing techniques used¹⁹. However, further studies are needed to increase the amount restorations, length of the time interval of evaluation, and the number of restorations to confirm the results of this study.

According to Silva et al.²⁰, the majority of authors agree that the use of aluminum oxide disks, such as the Sof-Lex disks (3M ESPE) and Flexi Cups (Cosmedent), are capable of producing surfaces with a low degree of roughness, because the abrasive particles present in these discs promote equal abrasion of the filler particles and the resin matrix. However, as regards aluminum dioxide disks, studies have reported that the shape of this instrument prevents access to certain areas of the tooth, and it has been found to be clinically time consuming, as it is applied in a decreasing sequence of abrasiveness; that is, multiple steps are required to achieve a clinically acceptable surface¹².

In more recent studies, Paravina et. al.²¹ and St-Georges et. al.²² assessed the new one-step polishing system PoGo. In this study, the results of using the PoGo finishing and polishing system, associated with nanoparticle resin composite were statistically similar to those of other systems assessed. Turkun et. al. (2004)²³ reported that the PoGo system produced better finishing in different composites than the Sof-Lex system. The difference in the cited study may be attributed to the characteristics of the micro-hybrid composites studied by the authors. These resins have more irregular particles that depend more on the characteristics of the polishing systems used to provide adequate smoothness. The results found were better than or equal to those

provided by the aluminum oxide disks therefore, this system has proved to be effective and capable of decreasing clinical working time¹².

CONCLUSION

Within the limitations of this study and based on the clinical significance of the results, we suggest that over 12 month period there was no adverse tissue response between the resin composite restorations of noncarious cervical lesions and periodontal tissues of patients with diabetes mellitus, irrespective of the type of polishing system used for finishing these restorations.

ADDRESS FOR CORRESPONDENCE

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