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Clinical Research

Gingival Health of Porcelain Laminate Veneered Teeth: A Retrospective Assessment

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Clinical Relevance

Porcelain laminate veneers offer a reliable and successful esthetic treatment, maintaining the long-term gingival health of the surrounding tissues.

SUMMARY

Statement of Problem: The long-term effect of the presence of porcelain laminate veneers (PLVs) on the health of the surrounding gingival issues is not available in the restorative literature.

Purpose: To assess the long-term effect of PLVs on the health of the surrounding gingival tissues. A secondary aim was to correlate gingival crevicular fluid (GCF) scores with clinical parameters used for gingival health assessment in teeth treated with PLVs.

Methods and Materials: Patients who received PLVs placed at the Graduate Restorative Clinic within a seven- to 14-year period were recalled for clinical evaluations. Periodontal measurements including gingival index (GI), periodontal pocket depth (PPD), gingival recession (GR), and clinical attachment level (CAL) were measured using a standard probe and indices. Gingival Crevicular Fluid (GCF) was measured with a Periotron machine (Periotron 8000, Oraflow Inc), using Periopaper (Periopaper Gingival Fluid Collection Strip, Oraflow Inc.) for fluid collection. Photographs of any observed clinical defect were taken. Data were tabulated using Excel 2010 (Microsoft Corp). Statistical analysis for all descriptive statistics was performed using SPSS 21 (SPSS Software, IBM Corp.) and Stata SE 13 (Stata Software, StataCorp). Repeated-measures analysis of variance (ANOVA) was done to test for statistical significance of the mean pocket depths between the restored and unrestored surfaces of the veneered teeth. The significance level for all tests was $p<0.05$. Pearson's correlation coefficient was performed for testing statistical significance between GCF and GI and between GCF and PPD.

Results: The frequency distribution of the GI included 47 PLVs (43%) with normal gingiva, 16

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(15%) with mild inflammation, and 46 (42%) with moderate inflammation and bleeding on probing. The average PPD on the facial surface of the maxillary and mandibular PLVs was 2.17 mm and 2.16 mm, respectively. On the lingual surface, the average PPD was 2.10 mm for maxillary and 2.22 mm for mandibular PLVs. Gingival recession was seen in 27% of the evaluated PLVs. The repeated-measures ANOVA revealed $p \geq 0.136$, showing no statistical difference in the mean pocket depths between restored facial and unrestored lingual surfaces of the veneered teeth. A moderate correlation ($r=0.407$) was found between GCF and GI, which was significant at $p<0.001$. No correlation ($r=0.124$) was found between GCF and PPD, which was not significant at $p=0.197$.

Conclusions: Gingival response to the evaluated PLVs was in the satisfactory range, with overall GI scores ranging between normal and moderate inflammation, pocket depths ranging from 1 to 2 mm, and recession present in 27% of the evaluated PLVs. No statistically significant difference was found between the mean pocket depths of the restored and unrestored surfaces of veneered teeth ($p \geq 0.136$). A moderate correlation was found between GCF and GI.

INTRODUCTION

The popularity of the bonded porcelain laminate veneer (PLV) has been consistently on the rise.[1] Over the span of 15 years, it became the second most requested porcelain restoration in the United States.[1] PLVs were introduced as a more conservative alternative to complete crowns. It is important for clinicians to understand the long-term clinical performance of these restorations. Gingival response to these restorations is of equal importance to the longevity of the restorations themselves. Since the advent of PLV treatment, a number of investigations with evaluation times ranging from 5 to 20 years have confirmed the favorable clinical performance of these restorations.[2-6] In addition, with PLVs, the maintenance of esthetics has been reported to be excellent with high patient satisfaction.[7]

Porcelain is considered the most esthetic and biocompatible material in dentistry with the ability to imitate sound enamel.[7] Based on these observations, one would expect no or even a positive reaction of the marginal gingival tissues toward porcelain veneers.[7] Clinical performance is tied to gingival health; therefore, studies have quantified and examined gingival recession, pocket depth, and gingival index (GI) in relation to PLV treatment.[4,8] Studies have investigated the effect of different restorations on gingival health with respect to margin placement, finish, and polish of the restorations.[9-13] Researchers have evaluated the correlation between gingival crevicular fluid (GCF) and periodontal indices, with some reporting a correlation between Periotron readings and clinical parameters[14,15] and some reporting no correlation.[16,17]

Short- to medium-term studies ranging from four to seven years have reported satisfactory gingival response to PLVs.[2,3,18,19] However, long-term clinical studies looking at the effect of the presence of PLVs on the health of the surrounding gingival tissues are not available. The present study aimed to bridge that gap and to provide, within its limitations, some information on this topic, which is still lacking in the literature. Therefore, the goal of this study was to evaluate long-term gingival health in response to PLVs, using clinical metrics for measuring gingival health. A secondary aim was to correlate GCF with clinical parameters used for gingival health assessment in teeth treated with PLVs. The null hypothesis tested was that the presence of PLVs will have no adverse effect on the gingival health seven to 14 years post cementation.

METHODS AND MATERIALS

The study was approved by the institutional review board and conducted according to approved guidelines. The inclusion criteria were subjects with PLVs placed within a seven- to 14-year period at the Graduate Restorative Clinic. These patients were identified by chart review and invited to participate. This was a sample of convenience, since all veneers were included and that number was fixed by previously performed clinical procedures over the stated time period. Patients were excluded if PLVs had fractured, been replaced by a new restoration, or if the veneered tooth was otherwise lost. In addition, patients could not be undergoing periodontal treatment at the time of veneer placement. Informed consent and updated medical history were obtained from those responding to the invitation. One calibrated evaluator recorded all measurements and photographs. A data collection form was used to record clinical parameters, which included the following.

The GI was obtained for three sites on each tooth—mesiofacial, facial, and distofacial—using the index scale described by Loe and Silness[20] and a periodontal probe (UNC Periodontal Probe, Hu-

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Friedy Mfg Co, Chicago, IL, USA), recorded to the nearest millimeter. Periodontal pocket depth (PPD) was measured using the same periodontal probe on six sites per tooth: mesiofacial, facial, distofacial, distolingual, lingual, and mesiolingual. The main purpose of recording the lingual measurements was to compare them with the values of the facial surface and evaluate whether the presence of PLV on the facial surface made a difference in the PPD compared with the lingual surface. Since baseline information was not available, accurate gingival recession could not be recorded. Therefore, anatomic crown exposure was recorded on three sites per tooth, mesiofacial, facial, and distofacial, as the distance in millimeters from the facial margin of the veneer to the cemento-enamel junction as fixed reference points. Clinical attachment level (CAL) was determined for three sites on each tooth, mesiofacial, facial, and distofacial.

For GCF volume, the area of the tooth to be examined was isolated with cotton rolls and gently dried with an air syringe. An absorbent paper strip (Periopaper gingival fluid collection strips, Oraflow Inc, Hewlett, NY, USA) was placed 1 mm into the mesial gingival sulcus of the tooth for 10 seconds to dry the crevicular sulcus and then discarded. Immediately, another paper strip was placed for 30 seconds (standard time for pooling GCF) and positioned in the Periotron (Periotron 8000, Oraflow Inc, Hewlett, NY, USA) to obtain the numerical readout.[21] A comprehensive calibration was done at the beginning of the study, then once per month and at any point during the study when an interim calibration was out of range. In addition, calibration was done according to manufacturer instructions immediately prior to taking readings on a participant. A log sheet was kept to record these readings and to validate sampling values. Once a reading was recorded for a PLV, the recorded score was divided by the mean of the calibration readings. The value obtained represented the GCF volume for each individual veneer. Photographs of any observed clinical defect were taken (Rebel XSI, Canon Inc, Melville, NY, USA).

Data were tabulated using Microsoft Office Excel 2010 (Microsoft Corp, Redmond, WA, USA). Statistical analysis for all descriptive statistics was performed using SPSS 21 (SPSS Software, IBM Corp, Armonk, NY, USA) and Stata SE 13 (Stata software, StataCorp LLC, College Station, TX, USA). Repeated-measures analysis of variance (ANOVA) was used to test for statistical significance of the mean pocket depths between the restored and unrestored surfaces of the veneered teeth. This repeated-measures ANOVA took into account the subject effect. The significance level for all tests was $p<0.05$. Pearson's correlation coefficient test was run to test the statistical correlation between GCF and GI and between GCF and PPD.

Table 1: *Distribution, Patient Demographics, and Location of Evaluated Porcelain Laminate Veneers*

Description	No.
Number of patients	24
Number of evaluated veneers	109
Number of male patients	7
Total number of restorations in male patients	24
Number of female patients	17
Total number of restorations in female patients	85
Location of veneers	
Number of mandibular	31
Number of maxillary	78
Distribution of veneers	
Central incisors	37
Lateral incisors	38
Canines	34

RESULTS

Record review and patient contact resulted in 26 patients with 114 PLVs presenting for examination. Of these, two patients with five PLVs were excluded, four PLVs had fractured and been turned into complete crowns, and one was turned into a complete crown to serve as an abutment for a removable partial denture. These were not included in the evaluation sample. Therefore, the study evaluated 109 veneers in 24 patients. Results of patient demographics, number of participants, total number of veneers evaluated, and location of the PLVs are given in Table 1. The frequency distribution of GI scores according to arch, PPD for restored facial and unrestored lingual surfaces of the veneered teeth, gingival recession by tooth surface, and CAL per arch are presented in Table 2. The GI scores recorded for the mandibular arch were higher compared with the maxillary arch ($p<0.0001$). The average PPD on the facial of the maxillary PLVs was 2.17 mm and on mandibular PLVs was 2.16 mm. On the lingual surface, the average PPD was 2.10 mm for maxillary PLVs and 2.22 mm for mandibular PLVs. The repeated-measures ANOVA revealed no significant difference in the mean pocket depths between the restored and unrestored surfaces, either overall or in the interaction with the subject (Table

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Table 2: *Frequency Distribution of GI Scores per Arch, PPD for Facial and Lingual Surfaces of Evaluated Porcelain Laminate Veneers, GR by Tooth Surface, and Average CAL per Arch*

Gingival Index (GI)

Arch	Score[a]	Inflammation	Frequency (n)	Percentage
Maxillary				
	0	Normal	43	55%
	1	Mild	11	14%
	2	Moderate	24	31%
	3	Severe	0	0%
	Total		78	
Mandibular				
	0	Normal	4	13%
	1	Mild	5	16%
	2	Moderate	22	71%
	3	Severe	0	0%
	Total		31	

Periodontal pocket depth (PPD)

PPD (mm)	Facial			Lingual		
	MF	F	DF	ML	L	DL
1	3	25	4	0	14	3
2	70	76	63	79	91	78
3	36	8	41	30	4	28
4	0	0	1	0	0	0

Gingival Recession (GR)

Surface	No Recession, n (%)	Recession, n (%)
MF	93 (85%)	16 (15%)
F	84 (77%)	25 (23%)
DF	98 (90%)	11 (10%)

Average Clinical Attachment Level (CAL)

Surface	Maxillary Arch	Mandibular Arch
MF	2.5	2.3
F	2.07	2.06
DF	2.53	2.25

[a] *Score = Loe/Silness GI index.*
MF=mesio-facial; F=facial; DF=disto-facial; ML=mesio-lingual; L=lingual; DL=distolingual

3). The teeth most likely to show recession in this study were maxillary lateral incisors (n=12) followed by canines (n=11) and central incisors (n=6). Figure 1 illustrates examples of veneered teeth exhibiting recession. With respect to the arch of the 29 PLVs exhibiting recession, 26 (24%) were maxillary PLVs and three (2.75%) were mandibular.

It was observed that the higher the GI score, the higher the value for GCF (Figure 2). Pearson's correlation coefficient revealed a coefficient (r) value of 0.407, signifying a moderate correlation between GCF and GI, which was significant at $p<0.001$. For GCF and PPD, higher scores were observed for 2-mm, as opposed to 3-mm, pocket depths (Figure 3). A coefficient (r) value of 0.124 revealed that there was no correlation between GCF and PPD, which was not significant at $p=0.197$.

Table 3: *Repeated-Measures Analysis of Variance for Mean Pocket Depths Between Restored and Unrestored Surfaces of the Veneered Teeth*

Effect	Num DF	Den DF	*F* Value	Pr > F
Subject	24	84	7.37	<0.0001
Surface	1	84	1.03	0.314
Subject × Surface	24	84	1.39	0.136

Num DF, Number of Degrees of Freedom; Den DF, Denominator of Degrees of Freedom; F Value, F statistic; Pr, P value

DISCUSSION

To the authors' knowledge, this is the only study evaluating the long-term effect of PLVs on the health of the surrounding gingival tissues and the only one to extend the follow-up time to up to 14 years. The null hypothesis that the presence of PLVs will have no adverse effect on the gingival health after seven to 14 years postcementation was accepted. The study found that, overall, of the 109 evaluated PLVs, 47 (43%) had normal gingiva with no bleeding on probing (BOP), 16 (15%) had mild inflammation, and 46 (42%) had moderate inflammation with BOP. None of the evaluated veneers had overt gingivitis with spontaneous bleeding. It was observed that as the margins of the veneers got closer to the gingiva, there was an increased tendency for BOP, and this observation is analogous to results presented in earlier studies.[4,8] Most of the veneers had a PPD of 1 to 2 mm, which indicated normal health of the surrounding tissues. The present study used the lingual gingiva of the restored veneered teeth as a comparison, which was previously described.[8] In another study, when PPD was measured on all tooth surfaces, no systematic differences were found when comparing measurements of the buccal versus the lingual maxillary anterior tooth surfaces in non-restored teeth.[22] The present study found no significant difference in the mean pocket depths between the restored facial and unrestored lingual surfaces of the veneered teeth. This finding has been reported previously.[8] A similar observation was also reported by an evaluation looking at class V composite restorations and class V glass ionomers restorations.[14,23] It is of interest to note that one study found periodontal indices, including pocket depth

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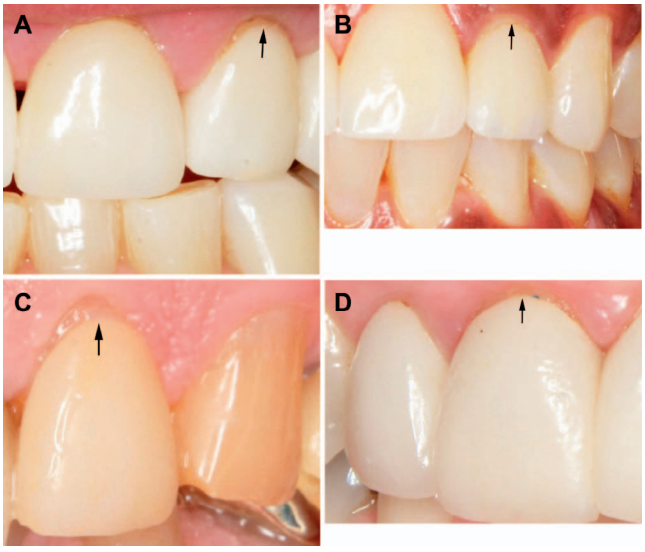

Figure 1A–D. *Examples of facial recession observed during recall appointments.*

and bleeding index, to be higher for porcelain fused to metal crowns compared with porcelain veneers.[8]

The present study found gingival facial recession in 27% (n=29) of the evaluated PLVs, and the reference for measurement was from the facial margin of the PLV to the free gingival margin. The same reference was used by another study, which reported 31% recession after 10 years.[4] Previously, a study reported an increased tendency for gingival recession of the veneered teeth after 5 years, which became more obvious at the 10-year recall.[5,24] The incidence of recession was more common in the maxillary PLVs; however, this may be due to skewed sample size. Maxillary lateral incisors followed by canines were found to be the teeth most likely to exhibit recession. The observed recession is most likely a result of time, which has been previously reported.[4] It has been found that recession may be seen on both veneered and nonrestored teeth.[4,5] In a longitudinal analysis, it was reported that even in subjects with a high standard of oral hygiene, buccal recession occurred frequently and the number of subjects presenting with recession increased with age.[25] It is of interest to note that patients and dental professionals have been reported to have different perceptions about esthetics related to gingival margin position, with patients not being able to observe recession up to 2 mm and dental professionals tending to rank lower esthetic satisfaction with the presence of recession.[26] In addition, operator variability and overzealous cord packing could have caused the margins to recede. It has also been suggested that occurrence of recession is

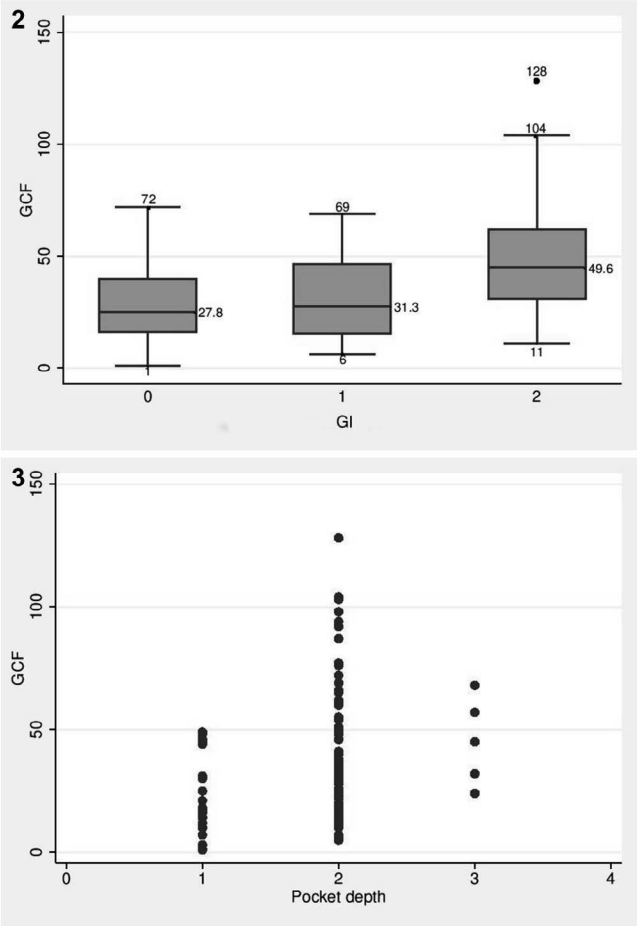

Figure 2. *Box plot displaying data values for gingival index, gingival crevicular fluid. For each gingival index score (0, 1, 2) minimum, maximum, mean scores of gingival crevicular fluid (GCF) are displayed with I- bars.*

GCF= gingival crevicular fluid; GI= Loe and Silness gingival index

Figure 3. *Scatter Plot displaying scores of gingival crevicular fluid, periodontal pocket depth (mm).*

GCF= gingival crevicular fluid; Pocket depth= mm

significantly related to equigingival or subgingival margins.[4] Therefore, wherever possible, margins of the veneers should be kept supragingival without violation of the biological width in order to expect the best gingival response.

The CALs are used not only to indicate past destruction of the periodontal attachment apparatus but also to monitor the progression of periodontitis. However, accurately assessing CAL can be difficult in the presence of inflammation and recession. Even though no overgrowth of tissue due to inflammation was observed, there was a trend for recession, and therefore, an accurate measurement of the CAL was difficult.

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A second aim of this study was to correlate GCF with clinical parameters used for gingival health assessment in teeth treated with PLVs. The study found a moderate correlation between GCF and GI (r=0.407), which was significant at $p<0.001$. This has also been observed by another study.[15] On the contrary, some studies found no correlation between GCF and GI.[16,17] It was observed in this study that the GCF scores of some PLVs were high, but the GI scores of the same PLVs were indicative of normal gingival health. This finding has also been observed by another study that suggested clinical indices to be crude for assessment of inflammation or the technique for sampling of GCF volume to be imprecise.[16] Lower GCF scores could have been obtained in this study, had the PLVs of patients been evaluated after their regular hygiene visit or if the supragingival plaque had been removed prior to evaluation. The presence of supragingival plaque has been reported to significantly elevate GCF scores.[27] The patients were instructed to get regular prophylaxis along with reinforcing the importance of brushing and flossing. Another reason for the higher GCF values seen in this study could be that a second sample of GCF was not collected. It has been suggested that the first sample is more closely related to the dimension of the crevicular space and the second one is more likely to be associated with the degree of inflammation.[16] In addition, the volume of GCF sample could be too small for accurate readouts, as it has been suggested that for lower volumes, errors in measurement may be high due to problems with evaporation, strip placement, and measurement technique, rather than errors related directly to the Periotron itself.[28]

This study found no correlation between GCF and PPD scores (r=0.124). However, one study did find a correlation between them.[15]

This study is not without limitations. These include the retrospective nature of the study, the sample being one of convenience, and the limited information available on certain aspects of the PLVs, including but not limited to the specific material used for fabrication of the veneers and operator variability. However, within the limitations of this study, it was found that after seven to 14 years of clinical service, the health of gingival tissues surrounding PLVs is not adversely affected by their presence.

CONCLUSIONS

Within the limitations of this long-term retrospective evaluation of gingival health around PLVs, the gingival response to the evaluated PLVs was in the satisfactory range, with overall GI scores ranging between normal to moderate inflammation, PPD scores ranging from 1 to 2 mm, and mild recession present in 27% of the evaluated PLVs. The teeth most likely to show recession in this study were maxillary lateral incisors. No difference was found in the pocket depths between the restored facial and unrestored lingual surfaces of the veneered teeth $p\geq0.136$. A moderate correlation was found between GCF and GI (r=0.407), which was significant at $p<0.001$. No correlation was found between GCF and PPD (r=0.124), which was not significant at p=0.197.

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Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of the University of Michigan. The approval code for this study is HUM00066344).

Conflict of Interest

The authors of this article certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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