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Oral Health Status and Gingival Response to Three Different Restorative Materials among Saudi Patients: A Clinical & Histopathological Study

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Abstract

Background: The correlation between oral health and dental restoration is fundamental. For the gingival and periodontal tissues to stay healthy, dental restoration should be in regularity with the surrounding tissues. This study aims to assess the oral health status and histopathological gingival response to three different restorative materials among Saudi patients. **Methods:** The study groups consist of 240 patients (50% males and 50% females), aged 18 - 45, with inclusion and exclusion criteria in the study. Participants are divided into three equal groups: those with composite resin restorations, those with amalgam restorations and those with glass ionomer restorations. Biopsies were taken from adjacent gingival tissues. Clinical parameters were determined by: plaque index (PLI), gingival index (GI) and clinical attachment loss (CAL). All data were collected and evaluated by through statistical analysis. **Results:** The clinical findings of the current study revealed that amalgam restorations produce a higher means of PLI, GI and CAL compared with composite resin restorations and glass ionomer restorations, but not insignificant levels, except CAL ($p = 0.004^*$). As for histopathological findings, there were significant differences in gingival tissue response to amalgam restorations, composite resin restorations and glass ionomer cement fillings, where there were statistically significant differences in numbers of chronic inflammatory cells ($p < 0.001$). **Conclusion:** At the end of the present study, we concluded that the amalgam restorations are less biocompatible compared to composite resin restorations and glass ionomer restorations.

Keywords

Gingival Response, Histopathological Study, Oral Health Status

1. Introduction

Gingival health and its maintenance are essential conditions for oral health. According to several studies conducted on human, there were unwanted gingival response and attachment loss adjacent to some dental restorations [1] [2] [3]. Consequently, the margins of dental restorations should be a fit correlation with adjacent gingival tissues, because the open margins and rough dental restorations facilitate plaque accumulation and development of gingival and periodontal diseases [4].

Nevertheless, some clinical and histological researches indicate that the extension of sub-gingival dental restoration may cause unwanted tissue impacts, even in good plaque controlled patients [5] [6]. Therefore, it's important to state that the mechanical and physical characteristics are considered to be a basic condition for dental restoration materials, quality assessment, in addition to gingival tissues biological response [7]. With regard to the biological assessment, the dental restorative materials that aren't triggering destructive responses in the adjacent gingival tissues are acceptable materials [8].

Biologically, composite resin fillings comprise reactive chemicals liberated into the oral and gingival tissues, and are more toxic through and promptly after 24 h of polymerization [9]. However, the effect of composite filling on gingival tissue per se may be not destructive effect and the adhesive characteristics of bacterial plaque may have more impact, according to the studies of Larato (1972), Dunkin & Chambers (1983) where they found gingivitis adjacent to composite resin restorations and the adjacent gingival tissue of non-restored teeth was not inflamed [10] [11]. Furthermore, many previous studies displayed that the accumulation of bacterial plaque on composite resin restorations is more than polished amalgam restorations [12] [13] [14].

Dental amalgam restoration is composed of mercury, silver, tin and copper with other metallic elements to improve mechanical and physical characteristics [15]. Lorscheider and his coworkers (1995) indicated that the main source of mercury in humans was the dental amalgam restoration. They have showed that this evidence doesn't confirm the toxicity of dental amalgam due to mercury [16].

Glass-ionomer restorations are a type of dental materials recognized as an acid-base dental filling depending on the reaction of polymeric acids with powdered glasses [17]. Biocompatibility of traditional glass ionomer restorations is acceptable [18]. There were many studies conducted on cultured cells which displayed that the light activated glass ionomer restorations had poor biocompatibility and greater cytotoxicity than the traditional glass ionomer restorations

[19]. To assess the biocompatibility of dental restoration materials, a series of tests must be done, including *in-vitro* examinations for their cytotoxicity in the adjacent gingival tissues [20]. In fact, there is restricted data on the clinical and histopathological gingival response and oral health status among Saudi patients being treated with three different restorative materials. So, the current study was designed.

2. Subjects & Methods

This prospective clinical study carried out on 240 patients (50% males and 50% females), aged 18 - 45. The patients are selected from the outpatient clinics of Periodontics and Community Dental Sciences Department (PCS), College of Dentistry, King Khalid University from August 2017 - February 2018. All the patients in the present study were in a good oral health and under the maintenance phase of periodontal therapy. Furthermore, they were without any systemic diseases and did not receive any antibiotics since six months.

The study was explained to the patients and a written consent, according to the applied protocol of the Scientific Research Committee, College of Dentistry, King Khalid University, was obtained. All participants filled the systemic and oral status form.

The inclusion criteria of the patient selection was based on evaluating the gingival tissues adjacent to three dental restorations, macrofilled filler composite resin restorations, amalgam restorations and glass ionomer restorations that were done dental restorative specialists before three months. These restorations extended into sub-gingival areas (class II & class V fillings) and needed correction after surgical crown lengthening by gingivectomy to obtain the specific histological samples from the adjacent gingival tissues of dental restorations (**Figure 1**).

Accordingly, the patients in the current study were divided into three equal groups (n = 80), group (I) included 430 restored teeth with composite resin restorations and group (II) included 410 restored teeth with amalgam restorations and group (III) included 420 restored teeth with glass ionomer restorations.

The clinical examination of dental restorations carried out by observation and the use of the explorer to assess the surface and margins of dental restorations in addition to using William's periodontal probe to evaluate periodontal clinical parameters. The periodontal parameters included plaque index (PLI, 0 - 3) [21], gingival index (GI, 0 - 3) [22] and clinical attachment loss (CAL).

The gingival biopsies 3 mm(from the dental restorations adjacent gingival margin)were taken under local anesthesia by sharp dissections (Bard-Parker blades no. 15) and they were put into 50% formoalcohol bottles (50 ml alcohol and 50 ml 10% formalin) for fixation into 24 hours (Histowax, Histolab, Gotenborg, Sweden) (**Figure 2**).

Samples were sent to the histopathological lab and the investigations were done after preparation of slides by the standard histological technique with hematoxylin and eosin stains (model 6062, SLEE, Mainz, Germany).

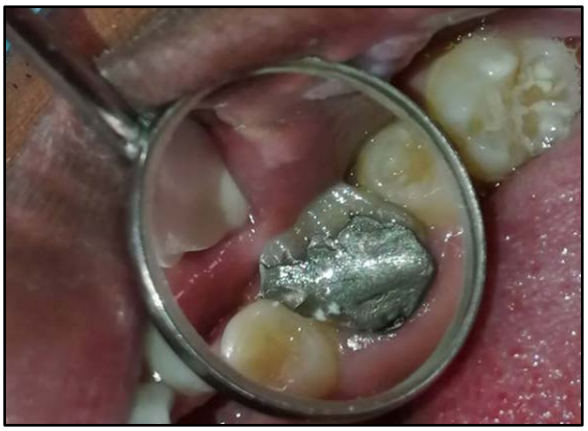

Figure 1. Clinical photograph of restorations extended into sub-gingival areas on #25, 26 & 27.

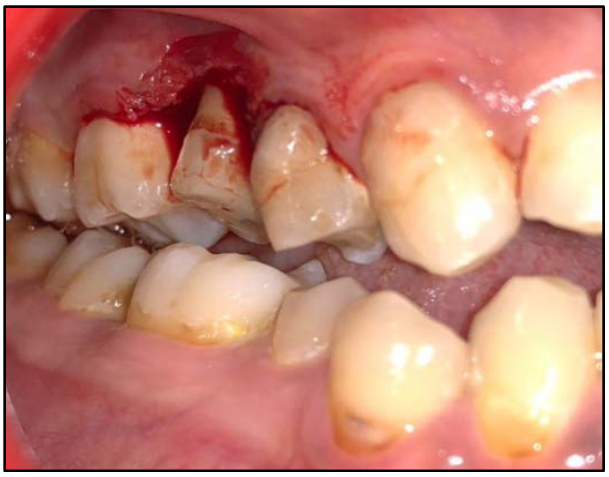

Figure 2. Clinical surgical crown lengthening for restorative purposes #14 & #15.

The histopathological investigation of all samples was conducted by a bifocal light microscope (Olympus B × 51, Olympus Corp, Tokyo, Japan) at X200 original magnification to evaluate gingival tissue reaction. The inflammatory response of gingival tissues, adjacent to dental restoration materials, was evaluated quantitatively under the microscope. The number of chronic inflammatory cells recorded as follows: no inflammation (no or few inflammatory cells); 1) mild inflammation (25 inflammatory cells). 2) moderate inflammation (increased reaction zone, 25 - 125 inflammatory cells). 3) severe inflammation (focal areas of necrosis, 125 inflammatory cells) [23].

The data were collected and assessed with statistical analysis by SPSS (SPSS Inc., Chicago, IL, USA) 21.0 statistical software. The results revealed by the assessment of mean ± standard deviation (SD) and there were statistically significant differences in clinical findings of the current study ($p < 0.05$).

3. Results

Two hundred and forty patients have completed this study without any compli-

cations related to the surgical procedures during crown lengthening to obtain the histological samples. The age and distribution of patients in the present study summarized in Table 1 and Figure 3 where 32% of patients included in group I and 35% in group II, moreover 33% in group III while the mean age and standard deviation of the group I, II and III were 29 ± 1.36, 31 ± 1.14 and 30 ± 1.52 respectively. Table 2, Figure 4 and Figure 5 reveal the clinical findings and number of chronic inflammatory cells of the present study where the mean of PLI, GI, and CAL of group II is the highest compared to group I and III. Moreover, the mean of chronic inflammatory cells number of group II is the highest compared to group I and III. That may be due to the roughness of amalgam restorations surfaces which facilitate bacterial plaque accumulation. Furthermore, in Table 2 and Figure 4 the mean of PLI, GI and CAL of group I is more than the mean of PLI, GI, and CAL of group III that may be attributed to the reaction of adjacent gingival tissues to composite resin restorations or deficiency in polishing of composite resin restorations particularly in the cervical and interproximal areas. Consequently, there were significant differences in all clinical parameters but without statistical significance differences except CAL where there were statistically significant differences in CAL in the comparison between the groups of this study ($p < 0.05$).

In the histopathological study of biopsy specimens of the present study, there were differences found in the comparison between groups I, II and III. The microscopic examination of biopsies revealed inflammatory response consisting of mild to moderate chronic inflammatory cell infiltration and mild to moderate dilated blood vessels in group I. Furthermore, moderate chronic inflammatory

Table 1. The mean and distribution of age.

Groups	Rang of age	Mean and ±(SD)*	
I	19 - 35	29 ± 1.36	
II	18 - 45	31 ± 1.14	0.453††
II	19 - 41	30 ± 1.52	

SD: Standard deviation. ††No statistically significant differences ($p > 0.05$).

Table 2. Mean and standard deviation (±SD) of the results findings.

	Clinical findings			Histopathological findings	
Groups	PLI**	GI***	CAL****	Number of chronic inflammatory cells	Inflammatory response score
I	1.4 ± 0.55	1.7 ± 0.7	2.3 ± 0.91	26.66 ± 4.26	2
II	1.6 ± 0.71	1.9 ± 0.62	2.9 ± 1.1	38.84 ± 2.65	2
III	1.3 ± 0.48	1.6 ± 0.67	2.1 ± 0.81	14.58 ± 1.2	1
P. Value	0.14	0.21	0.004‡	$p \leq 0.001$‡	-

**Plaque index; ***Gingival index; ****Clinical attachment loss. ‡statistically significant differences ($p < 0.05$).

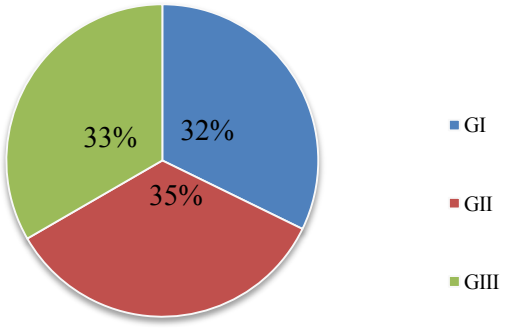

Figure 3. The mean and distribution of age.

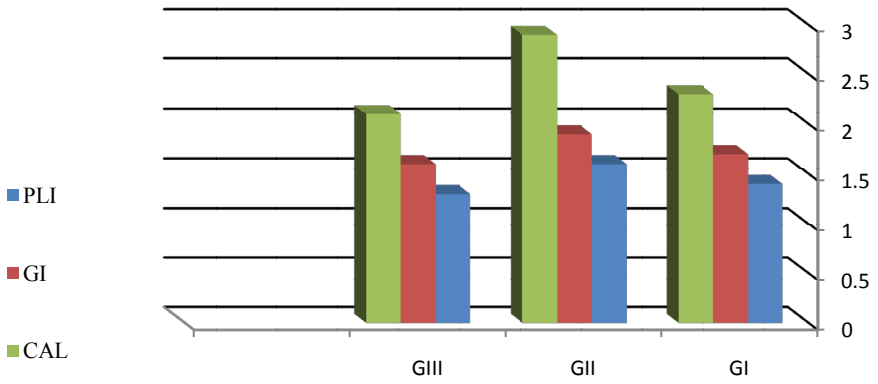

Figure 4. Clinical findings.

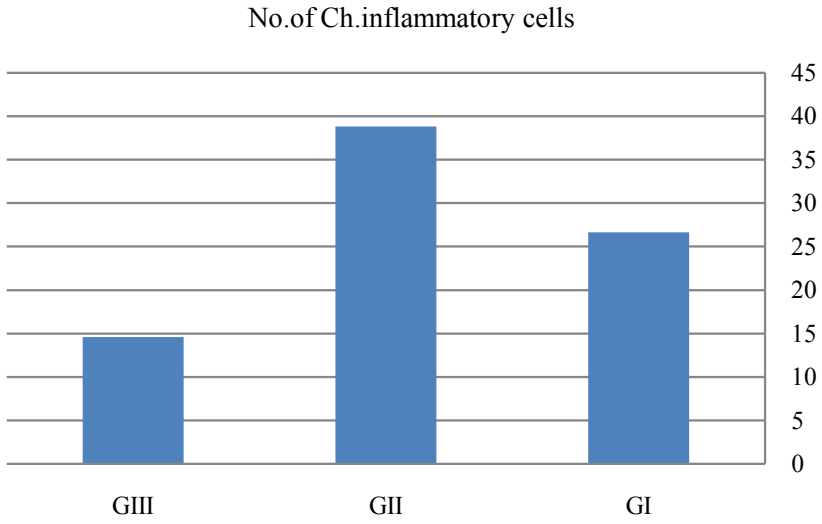

Figure 5. Inflammatory response assessment.

cell infiltration and moderate dilated blood vessels in group II, while it was normal to mild chronic inflammatory cell infiltration and mild dilated blood vessels in group III.

Generally, there were minor pathological changes in the adjacent gingival tissues of dental restorations. These pathological changes were mild to moderate in the samples of group I and moderate in group II, while these changes were nor-

mal to mild in group III.

Most of the biopsies of group I displayed mild to moderate epithelial hyperplasia and mild to moderate acanthotic change and mild to moderate inflammatory epithelial hyperplasia. Furthermore, moderate epithelial hyperplasia, moderate acanthotic changed and moderate inflammatory epithelial hyperplasia in group II, while these changes were normal to mild epithelial hyperplasia, normal to mild acanthotic changed and normal to mild inflammatory epithelial hyperplasia in group III (Figures 6-8).

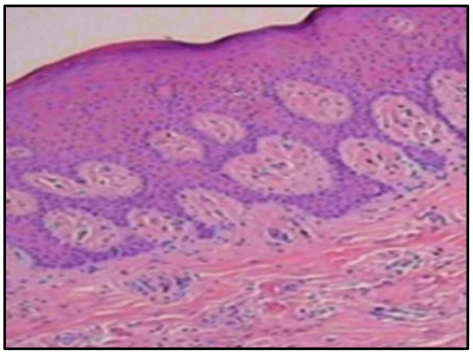

Figure 6. The biopsy of gingival adjacent of composite resin restoration displayed (stratified squamous epithelium with moderate chronic inflammatory cells.

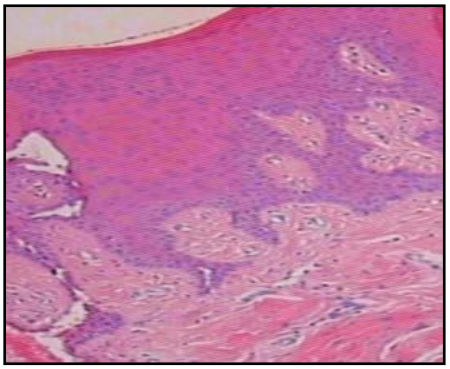

Figure 7. The biopsy of gingival adjacent of amalgam restoration displayed hyperplastic stratified squamous epithelium and chronic inflammatory cells.

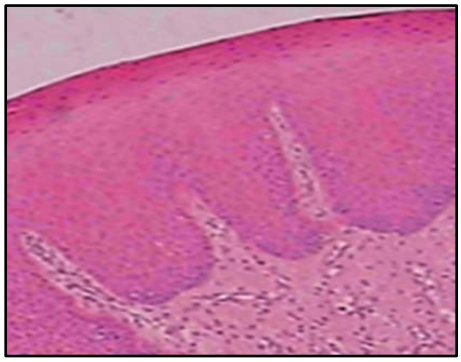

Figure 8. The biopsy of gingival adjacent of glass ionomer restoration displayed normal gingival tissue showing long rete pegs and mild chronic inflammatory cells.

4. Discussion

The potentially harmful impact of dental restorative materials on the gingival tissues has been the object of various clinical and histological studies [24]. According to (Leyhausen, 1998) study, there are possible impacts of dental restorative materials on oral and gingival tissues in different methods, particularly by the releasing water-soluble elements in saliva and by direct reaction with periodontal tissues [25]. Consequently, there are criteria for the selection of dental restoration materials for use in humans. It includes evaluation of four points as: the experimental evaluation, the assessment of their local reaction, the identification of the possible clinical hazard to save the patients and evaluation of the systemic side effects [26].

In Saudi Arabia, there are few studies conducted for assessment of the clinical and histopathological effects of dental restorative filling materials on the adjacent gingival tissues and oral health. This study is from the recent studies in Saudi Arabia that included the comparison between the effects of three dental restorative material fillings on gingival tissues and oral health. Within the last 20 years, composite resin restorations and glass ionomer restorations have been considered as restorative materials to the achievement of esthetic objectives in dental restoration procedures [27]. According to the data of earlier epidemiological studies, there were adverse effects of inadequate dental restorations such as margins shortage and rough surface on gingival tissues as a result of an increase of plaque retention and accumulation, where they found that the more severity of gingival disease in the areas of plaque formation and mechanical irritation [28] [29].

In the present study, primary examination positively displayed inflammation in gingival tissues adjacent to composite resin restorations, amalgam restorations and glass ionomer restorations may refer to the presence of some characteristics of these three dental restorative materials that are responsible for harmful effects on the gingival health status, due to their ability to keep of plaque consequently hinder plaque control.

It should be noted, and according to the studies of App (1961) and Trott & Sherkat (1964), there were significant differences in PLI, GI and CAL, in the comparison between group (I), which included control group and group (II) patients who are treated by amalgam dental restorations where PLI, GI and CAL were more in group (II) than group (I) [30] [31].

In the study of van Dijken JWV and Sjostrom S (1991), they have compared between one-year-old Class V, composite resin restorations, glass ionomer restorations and enamel surfaces. There was an increase in the degree of gingivitis adjacent to the resin composite resin restorations more than glass ionomer restorations and enamel surfaces without statistical significant differences, corresponding to the results of the present study [32]. Furthermore, correspond with the results of an earlier study which revealed that the fluoride-containing and leaching materials of glass ionomer restorations have inhibitory effects on the

growth of oral microorganisms [33].

Many of earlier researches agree with the clinical findings of the current study like the studies of Peumans *et al.* (1998) [34] and Paolantonio *et al.* (2004) [35], where they found the adverse effects of composite resin restorations on oral health and an increase in these adverse effects in amalgam restorations due to the nature of their surfaces. In the present study, it's found that the oral hygiene status correlated with the degree of PLI being higher with moderate oral hygiene adjacent to amalgam and composite resin restorations compared to glass ionomer restorations.

As it's known, the products of bacterial induce the inflammatory reaction of gingival tissues and their immune response then clinical attachment loss and bone loss due to the destructive effects of microbial plaque [36]. That is a confirmation of the results of the present study where it's found an increase in PLI, GI and CAL adjacent of class II fillings of composite resin restorations, amalgam restorations, and glass ionomer restorations, but the increase of these clinical parameters were in the adjacent areas of amalgam restorations more than composite resin restorations and glass-ionomer restorations.

The histopathological examination of 3 months results showed that moderate inflammatory reactions appeared in the sub-epithelial tissues of group I and group II, while there was mild inflammation reaction in the sub-epithelial tissues of group III. The persistence of a chronic inflammatory response to the composite resin restorations of this study are attributed to the continued breakdown or release of irritant products from the restorations, is similar to the results of Geurtsen (1998) [37] study, where Geurtsen found that there were gingival inflammation in histopathological samples due to release different products from a composite resin within 24 hours after polymerization.

Although in the current study, necrosis was not revealed in the composite resin restorations group, inflammatory responses may be due to the cytotoxicity of the components of this material. This finding agrees with the results of Geurtsen (2000) [38]. According to an earlier study which was done to evaluate the effect of amalgam restorations on the epithelial tissue in the oral mucosa, there were severe inflammation and tissue necrosis that attributed to the release of silver amalgam and more than 70% Hg0 vapor in the first day of dental restoration [39] [40].

These results correspond to the results of this study where it was found there is an increase in the numbers of chronic inflammatory cells in samples of group II more than group I and group III. In the study of Ziff MF (1992) [41] [42], there was a correlation between dental amalgam and oral lichen planus among some cases as allergic reactions to mercury and after the removal of amalgam, there were an improvement and remission of the lesions. These histological findings are in agreement with the histological results of this study, where the biopsies of group II patients displayed epithelial hyperplasia, acanthotic changed and inflammatory epithelial hyperplasia.

Finally, most of the published researches of the biological effects, evaluation of

glass ionomer restorations, revealed that these dental restorative materials were lower in cytotoxicity compared to the other dental restorative materials [43]. These reports are in agreement with the results of the current study where the gingival samples of glass ionomer restorations had the lowest severity of inflammation and, there were inflammatory cells infiltration and edema formation.

5. Conclusion

Depending on the inflammatory responses of the adjacent gingiva and despite the limitations in the current study, the researchers conclude that clinical and histopathological findings of the dental restorative materials in the present study do not exactly reveal their deleterious effect on oral health and periodontal tissues, but they comprise a preliminary phase in the assessment of their irritant effects.

6. Strength and Limitations

To our knowledge, no study has been done on oral health status and gingival response to three different restorative materials among Saudi patients in Aseer region. The strength of this study includes revealing if there is a correlation between severity of periodontal diseases and type of dental restorative material or there is no correlation, which is considered the gold standard to evaluate the biocompatibility of these materials.

The present study had many limitations. First, although all patients were receiving oral hygiene instructions and professional plaque control during the first visit before the surgical procedures, most of them have not responded to our instructions. Consequently, that caused delays healing in some cases after the operation. Second, the difficulty of using the cytotoxicity testing and cells culturing for evaluating the biocompatibility of the dental restorative materials due to the clinical and histological study cannot produce evidence of any significant correlation between cytotoxicity of the dental restorative material and periodontal tissue destruction; however, the results of the present study support the possibility of a causal relation.

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Conflicts of Interest

There are no conflicts of interest.

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