Effect of Class II Amalgam and Composite Restorations on Periodontal Health of Posterior Teeth: An in vivo study

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Abstract
Background Periodontal health at the restorative gingival interface continues to represent one of the most difficult challenges. Unfortunately, they only mimic the physical and morphological aspects of teeth, as they are limited by the absence of the 'ideal material' that would provide characteristics similar to the normal tooth structure. **Aims** To determine the influence of class II amalgam and composite restorative materials on plaque accumulation, gingivitis and periodontal pocket depth. **Materials and Methods** One hundred patients were included in the study. The age ranged between (21-24) years old. The sample was composed of two groups (50 patients each), with an equal ratio of males and females. The tested restoration types were: amalgam class II (MO) and composite class II (MO) of 2-3 years. The following periodontal parameters: plaque index (PI), gingival index (GI) and pocket depth (PD) in mm were recorded for each restored tooth compared with non-restored tooth on the other side of the mouth as a control. **Results** The results showed that amalgam induce the higher means of plaque, gingivitis and pocket depth compared with composite. The mean of the three parameters, as compared to control group, were statistically higher in the restored amalgam surfaces ($p<0.05$). For composite restoration the means of the three parameters were also higher but not in significant levels for both plaque index and gingival Index, except for pocket depth of the restored surfaces were significantly higher than the controlled surfaces. However, there were no significant differences in the ranks of the three mesial indices of patients having amalgam in comparison with those having composite. **Conclusion** This study suggests that composite restorations did not have a significant advantage on periodontal health over amalgam restorations for Class II posterior teeth.

Key words: Amalgam, composite, plaque index, gingival index, pocket depth.

Introduction

Dental restorations aim to restore tooth function, aesthetics and surface integrity. Unfortunately, in their effort to repair teeth and restore aesthetics and function, clinicians only mimic the physical and morphological aspects of teeth. They are limited by the absence of the 'ideal material' that would provide characteristics similar to the normal tooth structure (Albandar et al., 1995).
Periodontal health at the restorative gingival interface continues to represent one

of the most difficult challenges for the restorative dentistry due to the potential of plaque accumulation on the tooth surface.
Dental plaque is composed of various bacterial species embedded in a matrix of bacterial products. This bacterial biofilm stimulates gingival inflammation (Marsh, 2004). Thus, it is important to achieve better restoration contour and marginal integrity to minimize the effect of bacterial plaque (Gracis et al., 2001).
Many types of materials used to restore carious lesions in posterior teeth. Each material has its advantages and disadvantages. Basically, most of the dentists choose amalgam for posterior restorations. Think amalgam is safe and poses no health risks to the patient and it is the best material for posterior restoration (Nomann et al., 2013).
Demand for aesthetic dental restorations and public concerns about adverse systemic effects from dental metals and alloys have led to the increase use of dental composite restorative materials, which became very popular to the dentist (Gemalmaz and Ergin, 2002). However, maintaining periodontal health, even for correctly restored tooth surfaces, still a problematic issue (Banihashemrad et al., 2012). This makes the choice between amalgam and composite as restorative materials still an area of controversy.

Aims To determine the influence of class II Amalgam and Composite restorative materials on plaque accumulation, gingivitis and pocket depth.

Material and Methods

Patients sample selections

This study was conducted during the period between the 20th of February and the 20th of August, 2016. Hundred patients attended Al-Nadwa private dental clinical center, were examined. All examined patients were Erbil city residents. Participants were non-smoker young adults between (21-24) years old (Arneberg et al., 1980). The following types of restorations were examined: Class II (MO) amalgam and composite restoration with the gingival contact. The age of the restorations was within the period 2-3 years. All the restored teeth were in occlusion with the natural dentition and have proximal contact with adjacent teeth. All the restoration had been done by the same operator (Kiremitci et al., 2009). The technical procedure and the final restorative materials for amalgam (Spherical Alloy Self–Activating Capsule) and for composite restoration (Universal Nano Hybrid Z 250) were basically the same. The matching contra-lateral non-restored tooth served as a control for each restoration. The control surfaces were examined similarly to the restored surfaces (Al-babneh et al., 2011).
Out of the 100 patients included in the study, 50 were males and 50 were females. The sample size included 50 amalgam restorations (25 male and 25 female), and 50 composite restorations (25 male and 25 female). The number of control group was similar to the restored teeth included in the study.
Inclusion criteria: adult males and females with proximal restorations on on 1st and 2nd lower molar teeth, with regular oral hygiene maintenance (twice daily) with no particular attention to interproximal areas (Dijken et al., 1987). The included participants had restorations.
Exclusion criteria: patients wearing orthodontic appliances; pregnant ladies; ladies

within the period of hormonal changes; patients with systemic health problems with well established links to periodontal diseases, such as diabetes mellitus and patients who had received periodontal treatment within the last 3 months (Al-babneh et al., 2011).

Clinical periodontal examination

For each sample tooth, the periodontal examination was performed by a single examiner and the following parameters were recorded: plaque index (PI) (Silness and Loe, 1964), gingival index (GI) (Lo¨e and Silness, 1963) and pocket depth (PD) (Ramfjord, 1967). The PI, GI, and PD were recorded for each restored tooth and in the similar non-restored tooth on the other side of the mouth as a control. For each tooth, mesio-buccal surface was examined (Broadbent et al., 2006; Susin et al., 2005).
Dental probe was used for both plaque index (PI) and gingival index (GI) (CPITN Probe) (Abidi et al., 2011), whereas, Pocket depth (PD) was measured as described by Ramfjord (Ramfjord, 1967) from the free gingival crest to the level of attachment of the periodontium. The measurements were made with calibrated probes in millimeter's (University of Michigan "O" probe, with Williams's markings) (AL-Wahadani et al, 2006).

Statistical analysis

The data were analysed using the statistical package for social sciences (SPSS, version 19). Mann Whitney Test was used to compare the ranks of readings of the studied parameters (PI, GI, and PD) between patients for both amalgam and composite restorations. Wilcoxon signed rank test was used to compare the ranks of readings between restored and non-restored (control) surfaces for the same patients. A p value of ≤ 0.05 was considered statistically significant.

Result

Comparison

Table 1, Figure 1, and Figure 2 compare between periodontal parameters (PI, GI, and PD) of restored and non-restored (control) surfaces of the same patients having Class II amalgam and composite restorations.
Table 1 and Figure 1 show that the mean ranks of the three parameters (PI, GI and PD) are statistically higher in the restored teeth (amalgam class II mesial) than the controlled teeth ($p<0.05$). As compared with the control table (1) shows that (mesial) class II amalgam restorations have the higher means of (PI, GI, and PD) indices as compared with those of (mesial) class II composite restorations.
The same table and Figure (2) show that the means of the three parameters for (composite class II mesial) are also higher than the control group, but not to a statistically significant level for both Plaque index and Gingival index ($p>0.05$), except pocket depth of the restored surface of composite. Pocket Depth of composite restored surfaces was significantly higher than the controlled surface of the same patients ($p < 0.001$).

Table (1): Comparison between PI, GI, and PD parameters of restored and non-restored (control) surfaces of the same patients having class II amalgam and composite restorations.

		Plaque index		Gingival index		Pocket depth	
		Restored	Controlled	Restored	Controlled	Restored	Controlled
Amalgam class II mesial	No.	50	50	50	50	50	50
	Mean	1.16	1.02	1.50	1.38	2.24	1.78
	SD	.510	.622	.735	.725	.625	.545
	Median	1.00	1.00	2.00	2.00	2.00	2.00
	Minimum	0	0	0	0	1	1
	Maximum	2	2	2	2	3	3
	p^*	.008		.034		< 0.001	
		Restored	Controlled	Restored	Controlled	Restored	Controlled
Composite class II mesial	No.	50	50	50	50	50	50
	Mean	1.10	1.02	1.38	1.28	2.02	1.70
	SD	.544	.654	.753	.730	.589	.544
	Median	1.00	1.00	2.00	1.00	2.00	2.00
	Minimum	0	0	0	0	1	1
	Maximum	2	2	2	2	3	3
	p^*	.102		.272		< 0.001	

*By Wilcoxon signed rank test.

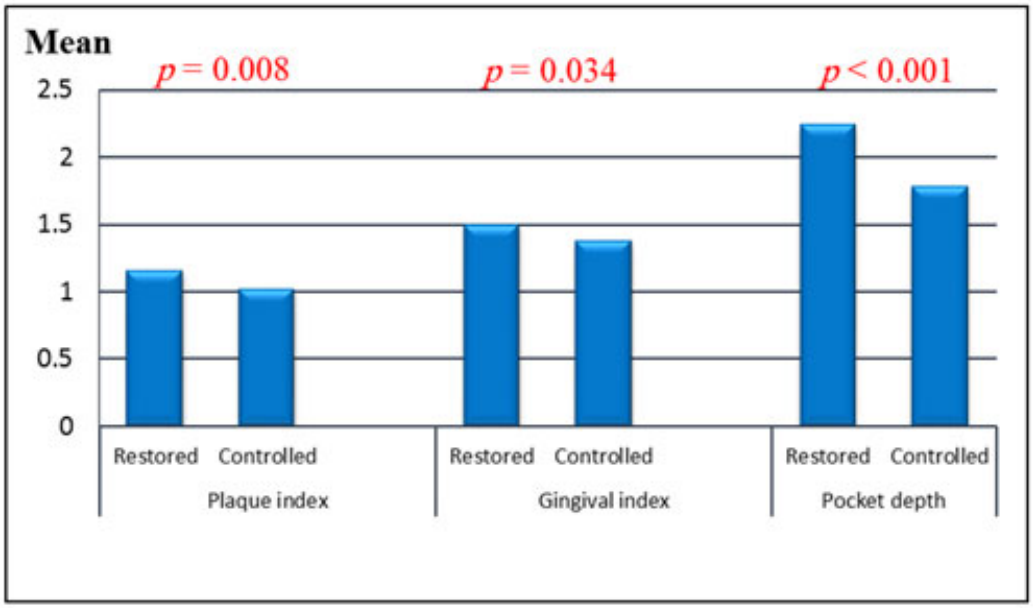

Figure (1): Comparison between the PI, GI, and PD parameters of restored and non-restored (control) surfaces of the same patients having class II amalgam restoration.

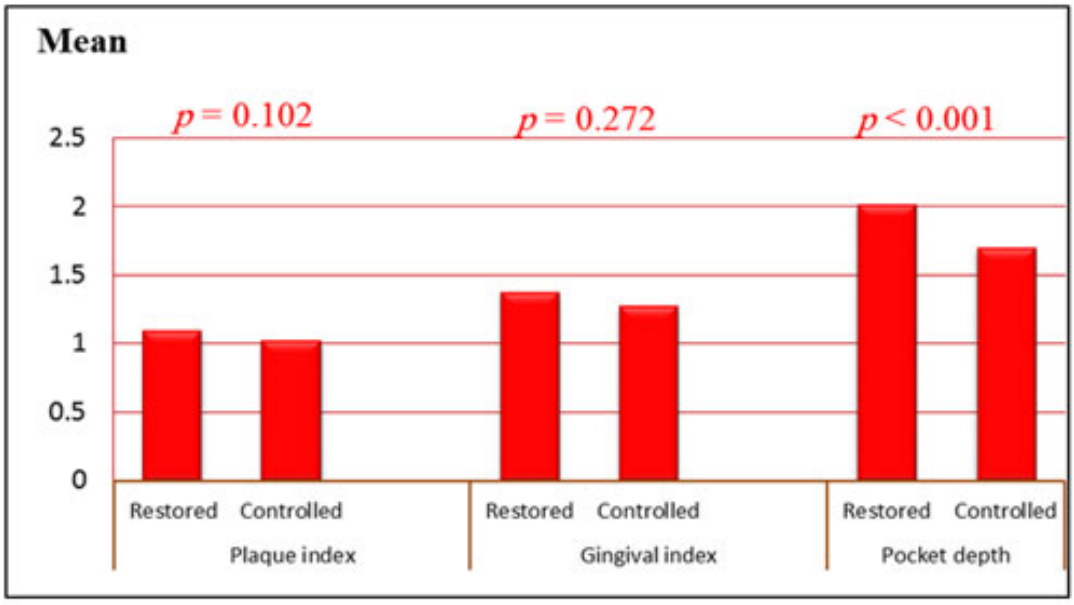

Figure (2): Comparison between PI, GI, and PD parameters of restored and non-restored (control) surfaces of the same patients having class II composite restoration.

Table (2) and Figure (3) compare the means of the three mesial indices of patients having amalgam and patients having composite restoration. They demonstrate no significant differences in the ranks of the three mesial indices of both restorations. They also show that the ranks of the mesial indices of the non-restored (control) surfaces of the amalgam group do not significantly differ from the ranks of the indices of the non-restored (control) surfaces of the composite group.

Table (2): Comparison of means of the three mesial indices of patients having amalgam and the means of the indices of patients having composite restoration.

Mesial indices	Restoration	Amalgam Class II		Composite class II		p*
		Mean	SD	Mean	SD	
PI	Restored	1.16	.510	1.10	.544	.588
GI	Restored	1.50	.735	1.38	.753	.361
PD	Restored	2.24	.625	2.02	.589	.068
PI	Controlled	1.02	.622	1.02	.654	.997
GI	Controlled	1.38	.725	1.28	.730	.460
PD	Controlled	1.78	.545	1.70	.544	.468

*By Mann Whitney test: comparing the ranks of indices of patients having amalgam and ranks of indices of patients having composite restoration.

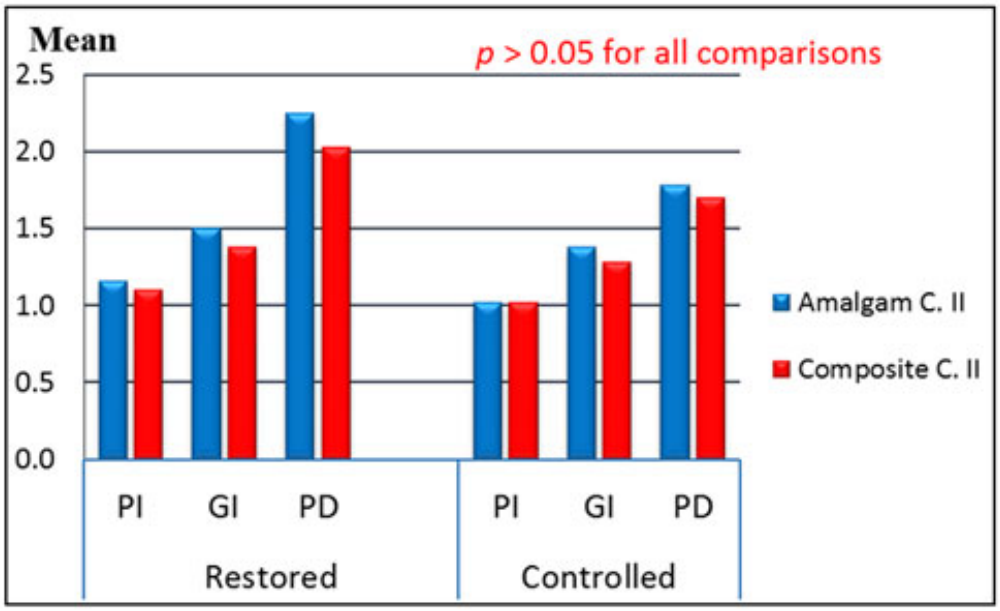

Figure (3): Comparison of means of the three mesial indices of patients having amalgam and the means of the indices of patients having composite restoration.

Discussion

Comparison between restored and non-restored surfaces

Plaque index (PI)

In this study it appears that class II amalgam and composite restorations have a higher plaque accumulation than controls. This might be attributed to several factors, such as the anatomical location of the restoration and the nature of the restorative material, which render these restorations either difficult to maintain and/or difficult to be cleaned. Amalgam is insoluble and its outer surface and interface which is in contact with dental tissues, is susceptible to tarnish and corrosion. Plaque is conducive to surface corrosion of amalgam.

The clinical studies analysing and comparing restorative materials with the consequent formation of gingivitis and periodontitis shows variations in plaque formation among restorative materials and sound dental enamel. Regarding this study the result is agreeing with other studies, which found significant differences in plaque indices between amalgam surfaces and non restored surfaces Davari et al., (2014), Renggli and Regolati, (1972).

However, this result disagrees with Ababneh et al., (2011) who showed no significant difference between restored amalgam surfaces and the control group. This might be attributed to poor proximal hygiene in this study group. This also might be explained by the lack of proper instructions provided by the dentists after tooth restorations. Patients in this group seem unaware of the fact that presence of restoration does not mean the end of the problem, and they should be informed that restoration surfaces need more attention.

Despite statistical analysis showed no significant difference between Class II composite restorations and control, still the mean value of plaque accumulation in Composite surface is higher. Composite restoration has a smoother surface compared to amalgam surface (Pandi et al., 2014). The result of the current study agrees with Ababneh et al., (2011). They found no significant difference between restored surfaces with

composite and controls. Ababneh et al., (2011) and Reitemeier et al., (2002) found that restored surfaces had less PI than control surfaces. They attributed this to the fact that patients were more aware of the restoration site and therefore probably cleaned it more. However, this disagrees with Davari et al., (2014) who reported statically significant difference between Composite surface and controlled tooth surfaces. This might be related to the type of composite used in the present study (universal nano hybrid). Azizi and Rezaei, (2009) showed that the Nano filler particles reduce surface roughness and bacterial adhesion. Very small filler particles result in high polish-ability and the smoothest surface among available composites.
Higher plaque accumulation on restoring surface might indicate lack of adequate use of interdental aids for plaque control in proximal areas. This mandates a change in the attitude of patients toward their oral hygiene habits with the presence of tooth restoration.

Gingival Index (GI)
As far as the gingival index is concerned, Class II amalgam restorations were associated with the high GI scores, which mean more significant gingival inflammation compared to control surface group. It is generally assumed that amalgam restorations induce gingivitis mainly by increasing the plaque retention, as reflected by the high PI scores on these surfaces, even with well adapted subgingival amalgam restoration, Renggli and Regolati, (1972), Banihashemrad et al., (2012), Davari et al., (2014) and Paolantonio et al., (1990), however, reported good biocompatibility of well-finished Class II amalgam restoration of gingival health. On the other hand, Albabneh et al., (2011) showed that amalgam Class II restorations were associated with higher gingivitis compared to non restored surfaces, though not to significant level.
Absence of significant effects of Composite restoration on PI score might reflect better biocompatibility to gingival tissue with less gingival irritation. This would result in less accumulation of plaque compared with amalgam restoration. Ababneh et al., (2011) reported that tooth-coloured materials (i.e. Composite) did not have a significant effect on the gingival health of restored surfaces when compared to controls. On the other hand Willershausen et al., (2001) reported high prevalence of gingival bleeding in association with resin-based restorations. Furthermore, Davari et al., (2014) showed that highly significant difference between class II composite restoration and non-restored teeth, Since PI for composite restoration in this study was not significantly different than control; it is expected to have less incidence of gingivitis. This reflects that smoother surface of composite accumulates less plaque and eventually result less gingivitis.

Pocket Dept (PD)
Amalgam was associated with higher periodontal involvement than composite. In general Class II (amalgam and composite) restorations were found to be associated with higher pocket incidence when compared to non-restored surfaces of the same patients ($p<0.001$). High PI scores on the amalgam restored surfaces, which are also consistent with the high GI scores (i.e. gingival inflammation) on these surfaces may be due to the cleaning difficulty for proximally restored tooth surfaces using a toothbrush without auxiliary Interdental aids. In addition, margin position and characteristics play an important role in determining periodontal tissue response to the restoration. This comes into agreement with previous studies (Albandar et al., 1995)

(Broadbent et al., 2006) (Banihashemrad et al., 2012).
Therefore, it is expected that this study results regarding class II amalgam restoration to agree with other studies. Ababneh et al., 2011 and Davari et al., 2014 studies found that amalgam was associated with significantly higher PD values than the control surfaces.
For Class II composite restoration the result agrees with Ababneh et al., 2011, Davari et al., 2014, Farias et al., 2008 and Willershausen et al., 2001.

Comparison between Class II amalgam and Class II composite restorations
Plaque index (PI)
It is generally agreed that different materials have different molecular distributions and surface chemistry, which could influence bacterial adhesion. This reflects the difference in dental biofilm growth rates on various dental materials (Grivet et al., 2000, Svanberg et al., 1990, Quirynen et al., 1989).
However, the result of the present study showed no obvious differences in the ranks of the three mesial indices for PI, GI and PD in amalgam and composite restorations. Class II amalgam restorations, were associated with the higher amounts of plaque compared to Composite, although not of significant value from. Lawaf et al., (2016) found that the adhesion of Streptococcus mutans to Nano-hybrid composite is lower than their adhesion to Amalgam. This might explain why periodontal indices are lower in composite compared to amalgam in this study.
Absence of significant difference between the two filling materials agrees with previous studies. Hannig, 1997 in a transmission electron microscope (TEM) study found no principal differences in the ultrastructure of the pellicle were observed between the different dental materials during the 6 hours of pellicle formation.

Gingival index (GI)
Each of these restorative materials has its drawbacks regarding gingival health. Rajan and Ramamurthy, (2014) stated that restorative resins lack adequate strength, develop porosity and wear off over time. Needless to mention the interaction between the resin with the organic compounds in toothpaste, plaque and soft drinks, which may have softened effect on composite material leading to surface roughness. This might explain the findings of Davari et al., who revealed that composite significantly higher in periodontal parameters than amalgam restorations (Davari et al., 2014).
Nevertheless, Rajan and Ramamurthy, (2014) also believe that materials such as amalgams (used in conventional interproximal restorations), require the highest possible degree of polish due to their interaction to the gingival environment. Surface roughness of these materials can provide foci for plaque accumulation and hence the need for polishing. Another in vitro study Kawai and Urano, (2001) examined the amount of bacteria adhering to different restorative materials using radioisotopes. Their investigation concluded that bacteria adhered more to amalgam compared to resin composite. Ababneh et al. (2011), however, did not find it statistically different from those of composite, which agree with the result of this study.
The higher gingival mean in Class II amalgam restoration as compared to Class II composite with no significant difference is agree with (Ababneh et al., 2011), but the result disagrees with Davari et al. (2014) who reported higher incidence of gingivitis in Class II composite compared to class II amalgam restored teeth with statistically significant difference. This has been explained earlier by the possibility of smoother

composite restoration used in the current study.

Pocket depth (PD)

The deepest PD values were found higher around both amalgam and composite restorations; this may be attributed to the high plaque accumulation observed around restored proximal surfaces, probably related to the reduced accessibility to cleaning. Age of the restoration might influence periodontal involvement. In the included sample the examined restorations were 2-3 years old.

Older restorations have more chance of periodontal problems due the accumulated plaque in the absence of interdental cleaning aids. As compared to controls, highly significant effects of pocket depth appear around Class II (amalgam and composite) restorations. Amalgam is associated with the greater periodontal breakdown than composite in agreement with Ababneh et al., (2011) who presented that amalgam was associated with significantly higher PD values than composite restorative materials.

Absence of significant differences between PD in (amalgam and composite restorations) agrees with Davari et al., (2014). However, they found that the mean score of PD was slightly higher in the group of Class II composite compared to Class II amalgam restorations. As suggested earlier, this might be attributed to the nature of composite filling used in this study. Davari et al., 2014, however, did not state the type of composite they used in their study.

Conclusion

This study suggests that composite restorations did not have a significant advantage on periodontal health over amalgam restorations for Class II posterior teeth.

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