

AN IN VITRO COMPARATIVE STUDY BETWEEN DIRECT AND INDIRECT –IN OFFICE- COMPOSITE RESTORATIONS REGARDING MICROLEAKAGE IN CLASS II CAVITY

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ABSTRACT:

Aim: the aim of this study was to evaluate the marginal and axial microleakage of class II composite restorations due to direct and indirect (in office) restorative techniques.

Materials and Methods:Forty human extracted premolars(without caries)were collected, and Class II cavities with standardized dimensions were prepared on each tooth, then the premolars were divided into two groups (n1=n2=20). The first group were restored with composite using direct restoration technique, and the second group were restored with composite using indirect restoration (in office) technique.All the specimens were subjected to thermocycling,then the teeth were immersed into methylene blue dye. After that, all teeth were sectioned according to marginal and then axial directions. Finally, the sections were examined under a stereomicroscope (×20) for microleakage evaluation.

Results:This study showed that there is no statistically significant difference between direct and indirect composite restorations in according to marginal microleakage where (P>0.05). On the other hand, this study showed that the indirect composite restorations has less microleakage on the axial wall than the direct composite restorations where (P<0.05).

Keywords:direct composite restorations - indirect composite restorations -microleakage –resin restorations.



INTRODUCTION

The developments which composite restorations have been incurred since the end of 1950 have helped in outspreading them widely in the field of operative dentistry. They have also had aesthetic characteristics in addition to their main role in preserving the original tooth structure ^[1,2].

However, new bonding agent systems have essentially contributed in enhancing resin composite bonding with dental tissue and increasing the success of these restorations too.

Polymerization shrinkage is considered one of the most difficult challenge ever that the composite restorations incur nowadays as it is one main contributor in existing the microscopic gaps within the prepared tooth's margins and the restoring material (resin composite) ^[3,4]. These gap, which are created as a result of the polymerization shrinkage, allow bacteria, molecules and ions to be passed towards the pulpal tissue, and this process so called marginal microleakage ^[5]. The marginal microleakage, and the minor gaps too, are basically in charge of the pulpal sensitivity posterior to the composite

restorations, and this will lead to the pulpal injury and fail the upcoming restorations [6].

Indirect composite restorations have been recently appearing during the last time aimed at overcoming the problem of the marginal microleakage in addition to facilitate the procedures of restoring the composite in office [7]. These restorations are made in the laboratory after taking an impression for the prepared tooth, and then the laboratorist restores the cavity over the gypsum, then it is polymerized suitably [8]. Thus, this technique leads to provide composite filling full-curing and in-laboratory sculptured. This filling would be later on adhered/ affixed to within the prepared cavity; and then, this will lead to overcoming the polymerization shrinkage posterior to the direct composite restoration. Evidence-based studies have proved the features of the indirect resin restorations including the mechanical characterizations, the chemical stability, the vital characteristics, the characteristics of the bonding of the dental tissues and the continuance in addition to its superiority over the ceramic restorations [9-12]. Additionally, many studies have been recently proving the importance of the indirect composite restorations in decreasing the marginal microleakage in comparing with the direct ones [13]. In spite of the characteristics of the indirect resin restorations (made in laboratories) which play a huge role in minimize the polymerization shrinkage, decreasing the marginal microleakage, achieving semi-

perfected polymerization of the resin in addition to facilitating the work within the office, there are some few notes about it such as [14]:

- 1- It needs more than one visit in order to complete the treatment; and thus, cavity pollution might happen between the visits.
- 2- It is much expensive.
- 3- Most of the time there will be a need to modify the indirect composite restorations made in the laboratory especially in terms of the occlusal surfaces; hence, it is suggested to make the indirect composite restorations directly in the office as an alternative to the direct composite restorations.

The new indirect composite restorations depend on the standard of making the filling in office after taking an impression for the prepared cavity. Then, the laboratorist restores the cavity on the gypsum then polymerizes it; after that, the dentist affixes it in the patient's mouth. It is noticeable that till this moment there is no evidence-based study makes a comparison between the in-office-made indirect and direct composite restorations in terms of the marginal microleakage, and this what this study tries to do so.

This study aims at a comparison between the traditional direct composite resin and the in-office-made indirect composite restorations (one session) in terms of the marginal microleakage

existed in the axial and gingival margins of the cavity of class II.

a- Restorations of the resin direct composite:

MATERIALS AND METHODS

1- Collect the specimens:

the specimens consist of (N=40) extracted human teeth including upper permanent and sound premolars as in the. These teeth are well-washed after being extracted and preserved in the saline solution (NaCl; 0.9%) for three months. However, the standards of choosing the teeth are as following: Permanent premolars of healthy and root-completed crown, No visible root absorption or any other cracks in the root, No malformations in the teeth, Free caries.

2- Preparing the specimens:

There has been prepared a class II cavity according to (G. V. BLACK) by using turbine diamond burs (lot: 836c 314018-Germany-sunshine). The width of the cavity was identified precisely through evacuant strip matrix of 4-millimetre width and of 0.04 thickness. It should be prepared previously according to the required distance and be affixed over a special matrix. Also, It has been identified the height at 2.5 mm through putting the green wax over the preparing bur according to the required length. Finally, It has been identified the depth of the degree at 2 mm which is the diameter of the bur used for the preparation.

3- Specimen restoration:

the restoration process of this specimen ($n_1=20$) was started through following steps: A)Putting metal matrix MOD over the specimen.B)The acid etching process: It is done through etching the prepared cavity by the phosphoric acid (total etch-ivoclarvivadent-germany) for 30 seconds for the enamel and 15 seconds for the dentin. C)The washing and drying process:The cavity is well-washed through directing a water stream vacant of oil in order to remove the phosphoric acid (for 20 seconds), then it will be dried with an air stream vacant of any water spray (for 5 seconds). This process ends with appearing the chalky colour of the enamel. D)Applying the bond:This bonding material (Tetric-N-bond-IvoclarVivadent-Germany) is applied through the head of the bond application (ultradent), and it should be moved for 15 seconds till the whole surfaces of the cavity are wet. After that, a delicate air stream is directed to the cavity in order to remove the redundant bond, then the polymerization is done through the polymerization device (LITEX695C-Dentamerica-USA) which is of 1000 millewatt/2cm for 20 seconds.

The composite is applied gradually (Optra sculp-IvoclarVivadent-Germany) with 1.5 mm thickness for each layer, and then it is compressed by special packs (Optra sculp-IvoclarVivadent-Germany); after that, the cure polymerization is started. However, the

methacrylate resin has been taken as a restorer of teeth which consists of filler materials including quartz atoms and resin mould containing the following constituents (TEGDMA, Bis-GMA ,Urethane Di Methacrylate) in addition to the coupling agent material.

b-restorations of resin indirect composite:

The specimen consists of ($n_2=20$) teeth, and the restoration has been done indirectly according to the upcoming stages:A)The teeth are insulated by silicates in order to facilitate removing them from the gypsum after being instilled in it. B)The specimens are instilled within special moulds full of yellow gypsum (siladent- Germany) but with leaving the crowns of the teeth appeared. The aim from making these moulds is to build a solid similar to the natural human jaw in order to facilitate taking the impression of the teeth. C)The gypsum, which contains the specimens of the teeth, is isolated from the plastic moulds, then the edges of the gypsum are trimmed in order to remove the growths by using the trimmer device and the manufacturing motor. D)Silicon impression is taken then (Zetaplus-Zhermack-Italy) for the whole specimen teeth in two stages by suitable plastic stamp. E)The impression is poured directly into special gypsum in order to get precise details of the specimen; however, the gypsum is distinguished with the quick polymerization as the same as the manufactured company (siladent-Germany). F)After completing

the polymerization, the gypsum is isolated from the stamps carefully so that we can get specific gypsum examples similar to the specimen teeth. G)The gypsum is isolated by silicates in order to prevent the gypsum atoms from being penetrating into the composite and to facilitate removing the fill later on. H)The composite is applied gradually (Tetric N-Cream-IvoclarVivadent-Germany) then polymerized according to the direct conditions mentioned above in a way the tooth is rebuilt through the restoration suitably; after that, the fillings are removed from the gypsum in order to polymerize the internal surface of restoration.

Before luting the indirect restorations, the internal surface of the restoration is treated by directing an air stream full of particles of aluminium oxide (AL_2O_3), whose volume is about 30-50 micron, for 2 seconds for each fill. The rubbing of the atoms of aluminium oxide with the interior of the fill can provide a rough surface of the composite which plays a role in increasing the surface energy and improving the adhering between the micro-mechanic fill with the tooth after being adhered ^[15].Finally,The monobond silane was applied over the whole internal surface of the fill, and then it is left for 60 seconds then dried by oil-free air stream.

On the other hand, the walls of each cavity were Etched by applying the phosphoric acid mentioned before. The etching was left for 30 seconds for the enamel and 15 seconds for the dentin,

then the tooth was washed out for 10 seconds and dried by oil-free air stream in order to get the chalky appearance of the enamel. The bonding agent, as mentioned before, was applied over the surfaces of the tooth desired to be filled as the same as the direct restorations status.

Finally, The luting material, which consists of flowable dual-cure composite (variobond N-ivoclar Vivadent-Germany) was prepared. Hence, The prepared cavity was filled with the flowable composite, then the fill is put into its place after pressing on it through rubber tool; after that, the over-cement was removed and then the light-cure polymerization was applied for continuous 20 seconds. After finishing the restoration, the whole specimens were put into an incubator with setting the temperature inside at 37°C, and they are preserved for 24 hours in order to complete the polymerization. After that, the teeth were into two vinaigrette cans, then the thermocycling is streamed at 200 thermo circles.

4- Evaluation the marginal microleakage:

first of all, the apical portion of each tooth were enclosed atomically with the yellow wax, then each tooth was covered with two layers of the nail polish in a way the associating zone between the composite fill and the tooth is preserved cleansed without polish. After that, all of the specimen teeth (N=40) were immersed with blue methylene dye

of 1% concentration for 24 hours in order to release the dye leakage around the composite restoration.

After removing the specimens from the blue methylene dye, they are washed with water stream for 15 minutes, then the teeth were splited by using a diamond disk of 0.1 mm thickness through the filling material as follow:

- 1- The first axis was towards the mesio-distal direction and in the middle of the restoration in order to study the gingival leakage.
- 2- The second axis was towards the lingu-buccal direction and in the middle of the occlusal surface in order to study the leakage on the axial margins.

The microleakage for all specimens was evaluated by The stereomicroscope, which is of 20x zoom, where, the gingival and the axial margin were divided into three equal thirds by using a regular ruler specialised in the photoshop program. Then, the point, to which the dye pentreated, was specified in the interface (between the composite and the tooth). So, according to this point, each specimen took a degree as the following: Figure (1)

0 degree: there is not leakage in the interface between the fill and the tooth.

1 degree: the leakage reaches less than third of the space in the interface

2 degree: the leakage reaches more than third and less than two thirds in the interface

3 degree: the leakage reaches more than two thirds and even most of the interface.

RESULTS:

1- The examination of agreement degree between the intra-examiner and the inter-examiner:

The degree of the agreement between the intra-examiner and the inter-examiner was identified according to the microleakage evaluation under stereomicroscope in the photoshop program analysis in a way it has been chosen a random specimen (N=20) from the whole specimens. The Kappa test for statistics in order to identify the degree of agreement between the intra-examiner and inter-examiner, and the results are summarized in the table(1). Kappa test showed that agreement degree of the intra-examiner was 84% with $p=0.0001$. Whereas, the agreement degree of the examiner with another examiner was 82% with $p=0.001$.

2- Comparison between the direct composite restoration and the indirect composite restoration in terms of the microleakage on the gingival margins:

The Mann-whitney test was used in order to compare between the indirect and direct restorations in terms of the

gingival leakage. The results are summarized in this table (2).

The results demonstrated that there was no statistically significant difference between the direct and indirect restorations in terms of the gingival leakage where ($P>0.05$).

3- Comparison between the direct and indirect restorations in terms of the microleakage on the axial margins:

the Mann-whitney test was performed in order to compare the direct and indirect restorations in terms of the axial leakage. The results are summarized in the table (3).

The results showed that there was a statistically difference between the indirect and direct restorations in terms of the axial leakage. thus, the axial leakage accompanied to the direct restorations was more than axial leakage accompanied to the indirect restorations where ($P<0.05$).

DISCUSSION :

The polymerization shrinkage in the resin composite restorations is considered undesired phenomenon. It leads to create microscopic gaps between the prepared tooth structure and the restoration. Consequently, these gaps cause the bonding failure between the tooth margins and the restoring material ^[16,17]; thus, the bonding failure will lead to increase the marginal microleakage ^[18].

However, the marginal microleakage is considered a main reason of failing the restoration because of passing the oral liquids such as saliva and others in addition to the molecules, which are between the tooth margins and the restoring material, towards the pulpal tissue via those gaps causing the post-restoration sensitivity posterior to the restoration in addition to the probability of restoration failure ^[19]. Additionally, the effective impressioning of the dentin tubules and its ability to resist the leakage is considered as a main factor in contributing in the durability of the restoration and its future success ^[20]. So, the study of marginal microleakage is considered one of the main issue that has an importance in the operative dentistry especially in terms of the indirect and direct restorative technique.

Some studies have shown that the indirect composite fillings have some clinical features specialized from the direct composite fillings in terms of the cordinal contact and in terms of its adaptation with the gingival margins of the prepared tooth margins in addition to its occlusal anatomic shape specialized from the direct ones ^[21,22].

Moreover, the steps in which the indirect restoration are applied contribute mainly in decreasing the marginal microleakage between the tooth margins and the composite especially near the dentin tissue ^[23].

Therefore, the indirect restorative technique is being dependable in this

study since its main role in facilitating the work and in summarizing the time in office in addition to its mastering in the technical work for these restorations on the gypsum. However, this method is considered a modern one because there has not been any study, till this moment, about comparing between these restorations and the traditional direct ones especially in terms of the marginal microleakage. Additionally, these restorations are distinguished with minimize the time in office and achieving the restoration in one session. Furthermore, the technique of the indirect restoration is distinguished with the process of manufacturing and polymerizing the fillings in the office which is done out of the oral medium; this helps in completing the final polymerization of the fillings before the luting/ adhering process. This contributes in decreasing the polymerization shrinkage process; and thus, decreasing the marginal microleakage.

In this study, it has been chosen human premolars in order to facilitate collecting the specimens of premolars, which own the required standards, in order to achieve the laboratory researches aiming at monitor the marginal microleakage. Additionally, there is a possibility of making a cavity of class II owning specific and desired features during preparing these premolars. This is especially in order to study both the marginal and axial microleakage. Finally, many studies, which analysed the marginal microleakage before, have chosen

human premolars in order to achieve the study [24,25].

However, it has been prepared a cavity of class II on the premolars in this study in order to facilitate analysing the microleakage existed between the indirect fillings in both the gingival and occlusal margins. Additionally, the association between the adhering materials with the enamel is considered an easy process comparing with the bonding with the dentin, which considers a challenge for the practitioners because of the component of these tissues. However, the class II cavity is distinguished with its comprehension of both the enamel and dentin tissues in the restored tooth in addition to the importance of the bonding to these tissues during preparing and restoring the cavity [26]. On the other hand, the indirect restoration is recommended in the case of prepared cavities which includes the gingival or sub-gingival margins [27].

The class II cavity differentiates from the class V cavity in a way the first includes the dentin only without being the gingival margin is in the level of the root or the cement. The huge number of the dentin tubules existed in the dentin root would increase the difficulty of etching the dentin tissues in that spot; moreover, the bonding strength would be weaker in the deep cavities which are among the cementum tissues [28].

In the current study, it has been used the technique of by using the bond (Tetric-N-

bond) and the etcher (Total-etch) of the fifth generation of the bonding system. This system exceeds other systems in terms of connecting the tooth tissues effectively. However, the fifth generation of these systems are considered the most widespread system among the practitioners in addition to the abundance of the researches about it [29,30].

Moreover, it has been chosen the composite (Tetric-N-Ceram) in order to achieve the both indirect and direct restorations since this kind of composite enjoys high-scaled mechanical features. Additionally, it considers one of the most familiar kind of composite used in the clinical application. Finally, this kind of composite includes nano molecules helping in improving the clinical characteristics and in decreasing the polymerization shrinkage too [31].

For bonding the indirect restorations, it has been chosen the composite of bi-polymerization (Variolink-Ivoclar-vivadent-Germany). The flowable resin enjoys the possibility of polymerization in both the chemical and (lightcure) interactions. The first polymerization (lightcure) achieves the primary polymerization for the direct restoration, while the chemical interaction provides polymerization for the rest of the adhering material especially in the restoration places where the lightcure can not reach. Thus, this way achieves semi-completed polymerization for the whole luting material in the interface (tooth-restoration) [32,33].

The aim of the thermo circles for the whole specimens before being put within the dye material is only to examine the various thermo differences within the oral environment especially those related to the variants affecting the teeth bonding (tooth-restoration); hence, it would affect the marginal microleakage which is the studied variant ^[34].

It has been chosen the method of dye monitoring about the amount of the marginal microleakage existed in this current study since it adopts easy steps. This technique was also dependable in most of the researches which studied the marginal microleakage ^[35].

Blue Methylene dye is chosen here as a monitor of the marginal microleakage since it is easy-used and cheap in addition to its big penetrance because of its molecular volume which is less than the internal diameter of the dentin tubes (1-4 μ m) ^[36]. Moreover, this method shows more positive results comparing with other ones ^[37].

This current study shows no important statistically difference between the direct and indirect fillings in terms of the marginal microleakage existed in the gingival margins even though there is a big difference between both techniques especially the adhering method. The direct restorative technique depends on bonding the fill directly to the etched surface via the adhering material; while the indirect restorative technique depends on the luting material (bi-

polymerizing flowable composite) in order to achieve the bonding of the indirect restoration to the tooth surface. However, as mentioned above, there has not been any previous study comparing between these two techniques in terms of the marginal microleakage, but there was a study (Soares, C 2005) which showed that there is no difference between the direct and indirect fillings (which are made in laboratory) in terms of the leakage existed in the gingivo-enamel margins ^[38]. However, that study proved the exceeding of the indirect fillings on the dentino-gingival margin over its peers in terms of the leakage existed there, and this opposes the result of this current study. However, the previous study depended on studying the leakage existing in the gingival margin in the level of the enamel and dentin tissues separately. On the other hand, the current study depends on analysing the leakage on the gingival margin as a whole regardless the tissue (enamel or dentin tissue).

The final result is attributed to the nature of the dentin tissue in addition to the abundance of the dentin tubules near to the cemento-enamel junction which affects the direct restoration bonding with the dentin surface; and thus, it will increase the probability of the marginal microleakage ^[39].

One study showed, accordingly with the results of this study, no difference between the direct and indirect fillings in terms of the marginal microleakage even though, in one hand, it depends on three

molars to complete the study; however, this study depends on upper premolars, On the other hand, the previous study depends on ordinal indicators in order to measure the leakage including five degrees (0-4), while the current study depends on indicator including only 4 degrees^[40].

CONCLUSIONS:

Under the condition of this study, it could be concluded that:

- 1- There no difference between the indirect and direct fillings in terms of the marginal microleakage on the gingival margin.
- 2- The exceeding of the indirect fillings over its direct peers in terms of the marginal microleakage on the occlusal margin.

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TABLES:

	The stratification degree Kappa	P – value
Intra-examiner	0.848	0.0001
Inter-examiner	0.829	0.0001

Table (1) a test of stratification degree between the intra-examiner and inter-examiner

The restoration type	Average arrange of the gingival leakage	The sum of the arranges	Mann-whitney value	P value
Direct	20.10	4.2	192	0.813
Indirect	20.9	4.18		

Table (2) this table shows the Mann-whitney to compare between the restorations types in terms of the gingival margins.

The restoration type	Average arranged axial leakage	The sum of the arrangements	Mann-whitney value	P value
Direct	24.28	4.85	124.5	0.028
Indirect	16.72	3.34		

Table (3) Mann-whitney test to compare the restorations types in terms of the leakage in the axial margin.

FIGURES:

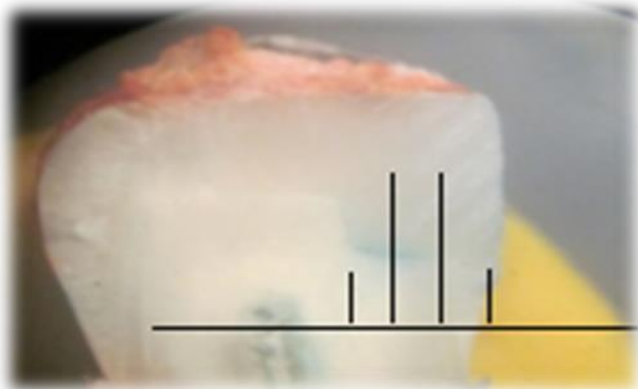


Figure (1): shows evaluation of microleakage on gingival wall of direct composite restoration.