M D J

Influence of Closed Sandwich Technique on Marginal Seal of Class II Restorations with Different Substrates using LED Curing

Dr. Shatha Abdullah Salih B. D. S., M. Sc., Lecturer.

Abstract

This study was done to evaluate the microleakage at the tooth restoration interface in different substrates when glass ionomer was used as a base which covered by a veneer of resin composite, as closed sandwich technique, with light -emitting diode (LED) curing.

Eighty Class II cavities were prepared in mesial and distal of extracted molars, mesial cavities with gingival margins in enamel (E) and distal cavities with gingival margins in dentin(D), were divided into four main groups (G)s, each group was subdivided into GE and GD of ten cavities for each and filled as follows:

GI each cavity of GIE & GID was filled with composite and cured with halogen light curing unit (H), GII each cavity of GIIE & GIID was filled with glass ionomer lining and composite and cured as GI, Group III each cavity of GIIIE & GIIID was filled as GI but cured with LED while Group IV, each cavity of GIVE and GIVD filled as GII and cured as GIII. After restorations, the teeth were thermocycled 300 times, soaked in 0.1% methylene blue for 24 hours, sectioned and microleakage from the gingival margin scored. Statistical analysis was performed using t-test.

There was no significant difference when use sandwich technique in enamel but There was significant difference in dentin ($p \leq 0.05$), while no significant difference when the comparison between enamel and dentin, whether LED or H curing was used.

With sandwich technique, the marginal adaptation of enamel margins was not dependent on the restorative technique while marginal adaptation in dentin was significantly better. The use of LED had no adverse effect on microleakage.

Key words: Sandwich technique, LED, Marginal seal.

Introduction

Light cured composite resin materials have several advantages such as control of the contour during placement of the restoration, better color stability, and a more complete polymerization compared to chemically activated materials [1]. An inherent disadvantage of these materials is they contract during light polymerization [2]. So In general excellent results cannot be guaranteed when using resin-based composites for posterior restorations. This is due to polymerization shrinkage which can still be regarded as the primary negative characteristic and the major drawback for these aesthetically adaptable restorative materials [3, 4]. Polymerization shrinkage is one of the causes of marginal gaps as well as marginal microleakage [5, 6]. Therefore to minimize polymerization shrinkage, authors propose different techniques for placing direct, posterior, resin-based composite restorations. One of these techniques is the use of sandwich technique, in which glass ionomer cement is used as a lining under composite resin restorations [(7)]. Also the clinical performance of light polymerized resin-based composites is greatly influenced by the quality of the light curing unit (LCU). Development of new blue super bright light emitting diodes of 470 nm wavelengths with high light irradiance offers an alternative to standard halogen LCU[(8)] and it has been reported that LED technology has a promising future [(9)].

With the increasing frequency of use of posterior composite, methods are needed that minimize leakage and provide patients with a more successful restoration. The purpose of this in vitro study was to evaluate the ability of closed sandwich technique and LED curing in reduce microleakage at the tooth restoration interface in different substrates

Materials and Methods

forty noncarious and crack-free mandibular third molars were used. The teeth were randomly divided into four groups each containing ten teeth. Class II box-like cavities without occlusal retention cavity and any mechanical retention means were prepared on each tooth, mesially (E) box was terminated in enamel (The gingival margin was located 1 mm above the cementoenamel junction), and distally (D) box was terminated in cementum (The gingival margin was located 1 mm below the cementoenamel junction) [(10)] by means of a high-speed handpiece, using a rounded fissure diamond bur with adequate water-cooling, so each main group was subdivided into E (of ten cavities) and D (of ten cavities) according to the gingival margin. The bucco-lingual width was 4 mm and the mesio-distal depth of the cervical margin 1.6 mm, fig. (1, 2). The prepared cavities, as are shown in fig. (3) were filled as follows:

1-GroupI each cavity of GIE & GID was filled with (micro-hybrid resin composite) and cured with DentSuply (Quartz Tungsten Halogen light unit, QTH), with constant intensity of approximately 450mw/ cm².

2-Group II. each cavity of GIIE & GIID was filled with glass ionomer lining and (micro-hybrid resin composite) and cured with (QTH), the same as GI

3-Group III each cavity of GIIIE & GIIID was filled with (micro-hybrid resin composite) and cured with Radii (Light Emitting Diod, LED cure unit), with intensity of 1200mw/ cm².

4-Group IV each cavity of GIVE & GIVD filled as GII and cured as GIII.

The glass ionomer lining (3M ESPE Ketak Molar Easymix, it's application according to the manufacturer instruction), One scoop of powder was mixed with 1 drop of liquid on a paper pad using a small cement spatula and applied up to the gingival cavosurface margin of the gingival floor with the round end of a Dycal applicator (SP6061, Hu-Friedy, Chicago, Ill.) to a thickness of about 1 mm, (this was calibrated by measuring with a pre marked periodontal probe). After that, the small end of a hoe was used to remove 0.5 mm of glass ionomer along the gingival margin to expose the dentin. The cavity was treated with self-etch (Xeno v): self-etching dental adhesive Bonding system. It is all in one, composed from acid, primer and bonding agent in one solution. It is applied sufficiently and wetting all surfaces uniformly. Then gently agitate the adhesive for 20 seconds. Then the solvent evaporate thoroughly by air blow for 5 seconds. After that cure it for 20 seconds. If the surface was not uniformly shiny, the process was repeated [11]. Pieces of stainless steel matrix band were burnished and fixed to the teeth with impression compound for better adaptation [12]. For filling with composite restoration (micro-hybrid resin composite shades A2), the manufacturer's instructions were followed, and dental composite was filled incrementally of 2mm and cured for 40 s with either a commercial halogen LCU or a LED LCU, for each increment. After placing the composites, each sample was finished with silicone points. Samples were stored in distilled water at 37°C for seven days, before thermocycling in baths of 30-second dwell time, at +5°C /+55°C, for 300 uninterrupted cycles. The root apices were sealed with sticky wax, and the teeth were covered with two layers of nail varnish except for the area of the restoration and a 1 mm border of tooth surrounding each cavity. All teeth were soaked in 0.1% methylene blue for 24 houres, All specimens were sectioned along a mesio-distal plane through the middle of the cervical margin. To assess dye penetration, the cervical areas of the sections were examined using an optical microscope [13] and microleakage from the gingival margin scored [14], the microleakage scores were chosen as follows: 0 – no penetration, 1 - penetration up to 1/2 of the depth of the cervical margin, 2- penetration more than 1/2 of the depth of the cervical margin, 3 - penetration along the axial wall [13].

Results

The readings of dye penetration by microscopic examination at 40X magnification for all samples were done by two examiners, and the percentage for each score was represented by table(1).

The descriptive statistic for the mean score values and standard deviations of the microleakage of enamel & dentin for different groups had been shown in tables (2, 3 and 4).

From the table (2), the score mean values of microleakage of enamel groups had less mean values of the microleakage than dentin groups and by using t- test, there were significant differences between the enamel and dentin margin groups at $p \leq 0.05$, with in favor of enamel margin groups.

But with the use of sandwich technique, (G2E+4E, G2D+4D) microleakage had less score mean values than without sandwich technique groups (G1E+3E, G1D+3D) and by using t- test, there was no significant difference between the enamel and dentin margin groups at $p>0.05$, this represented an improvement in the integrity of dentin margins.

Table (3) shows that the groups with out sandwich technique had higher score mean values of microleakage which were (.88, .60 and 1.15) than with sandwich groups (.40, .25, and .55) respectively, i.e., the use of glass ionomer as a base beneath composite resin restoration reduced the micoleakage of enamel and dentin margin.

By the use of t- test, there was no significant difference between the enamel groups at $p>0.05$ but between dentin margin groups there was significant difference at $p \leq 0.05$, with in favor of use sandwich technique

Table (4) shows the highest score mean value of microleakage (1.00) with groups used halogen curing without sandwich technique, while the lowest score mean value of microleakage (0.4) with groups used halogen or LED curing with sandwich technique.

T-test revealed that there were no significant differences between groups used halogen and LED curing whether with or without use of sandwich technique at $p>0.05$, and this mean LED curing had no adverse effect on microleakage.

Discussion

Microleakage tests have been widely employed to screen the seal efficiency of restorations [10, 15]. Microleakage is a phenomenon of the diffusion of organic or inorganic substances into a tooth through the interface between the restorative material and the tooth structure [16]. It is a common phenomenon and is hard to avoid because several factors are involved and is not dependent only on the composite or the adhesive performance. These factors could be the technique sensitive, operator ability, substrate quality (dentin), etc [12]. therefore different techniques for placing direct, posterior, resin-based composite restorations were proposed these can minimize polymerization shrinkage, some authors propose the use of sandwich technique in which the use of glass ionomer cement, as a base combined with a veneer of composite resin, has been advocated as a means of minimizing microleakage [17].

Sandwich restorations with conventional glass ionomer cement were introduced in the early 1990s [18, 19], in which the resin composite is replaced in the dentin part of the cavity by another material with lower elastic modulus the first horizontal layer can be conventional glass ionomer cement.

In this study closed sandwich technique was depended, this is because authors found deterioration on the surface exposed to a simulated oral environment when glass ionomer liner was extended out to the cavosurface margin (open-sandwich technique) , but no deterioration in samples with the glass ionomer liner protected by a veneer of composite resin (closed-sandwich technique) [11].

The result of this study showed that without using of sandwitch technique, dentin microleakage values were greater than enamel microleakage values and there was significant difference at $p \leq 0.05$ and this is agreed with Smith, et al 1992, Tulunoglu, et al 2000 , Tredwin, 2005 [14, 17, 20].

Enamel margins generally produce consistent bonding and microleakage is less likely than with dentinal margins [21, 22]. Clinically, however, margins are frequently placed apical to the cementoenamel junction, on dentin or cementum where moisture control and access for finishing are more problematic. Dentin bonding is more difficult because the heterogeneous nature of the tissue requires the bonding system to accommodate simultaneously the properties of the hydroxyapatite, collagen, smear layer and dentinal tubules and fluids [23]. Consequently, the ability to achieve an effective seal at the gingival margin becomes even more important in terms of the longevity of a resin restoration.

The present study revealed that for margins in enamel there was no significant difference between groups with and without using of sandwich technique at $p>0.05$ and this is agreed with. Dietrich, et al 1999, who improved that the marginal adaptation of enamel margins was not dependent on the restorative technique [24]. And this is because Enamel is basically an inorganic tissue and, therefore, a more stable substrate for adhesion, promoting a better marginal seal [10].

But for margins in dentin there was significant difference between groups with and without using of sandwich technique at $p \leq 0.05$. While when the present study compare between enamel and dentin margins with sandwich technique there was no significant difference between microleakage of enamel and dentin margins. This is may be explained by the use of sandwich technique which can minimize polymerization shrinkage in which Chemical adhesion between glass ionomer cement and dentine is accepted as being a long-term union and it has been shown that a mechanical union is possible between composite resin and glass ionomer cement [7].

So the use of a low viscosity resin, has resulted in improved sealing of composite restorations, when enamel is absent and margins involve dentine or cementum [17].

The magnitude of stress developed at the restoration interface is related to the compliance of the surrounding structures. If the substrate to which the shrinking composite is bonded can yield to contraction forces, the developed stress is lower. The application of a low-elastic-modulus material to the cavity walls represents a way to increase the compliance of the prepared cavity artificially [25].

And this is agreed by some authors who improved that for margins in dentine, marginal adaptation was significantly better with the sandwich technique than with a composite resin alone [17, 24], and also agreed with Lawrence and Susan 2007 who improved closed sandwich technique remains an effective method for reducing microleakage when proximal boxes have gingival cavosurface margins located in dentin [11].

A variety of curing lights are available for the photo polymerization of light cured dental resins. The most common approach is the conventional halogen LCU. It has been shown that halogen curing light deliver an inadequate light intensity. LED technology may overcome some of the drawbacks of halogen LCU's; consequently, LED technology has a promising future [26]. It has been reported significantly less microleakage occurred at the dentin/cementum interface when restorations were cured with an LED unit compared to curing with the standard halogen LCU, however, no significant difference in microleakage was found between LCU's at the enamel interface [9, 27]. In this study there were no significant differences between LED and halogen LCU's both in enamel and dentin.

Conclusions

Within the limitation of this in vitro study it can be conclude that:

1. None of the examined groups totally prevented dye penetration
2-Without sandwich technique enamel marginal seal significantly better than dentin.
3-With sandwich technique there was improvement in dentin marginal seal and there was no significant difference with enamel.
4-With or without sandwich technique, LED curing had no adverse effect on marginal seal of different substrates.

References

1- Burgess JO, Walker RS, Porche CJ, Rappold AJ.: Light curing--an update. Compend Contin Educ Dent 2002; 23: 889-892.

2- Yap AU, Wang HB, Siow KS, Gan LM.: Polymerization shrinkage of visible-light-cured composites. Oper Dent 2000; 25: 98-103.

3- Uhl A, Mills RW, Rzanny AE, Jandt KD: Time dependence of composite shrinkage using halogen and LED light curin. Dent Mater. 2005; Mar; 21(3):278-86.

4- Giachetti L, Scaminaci Russo D, Bambi C, Grandini R: A review of polymerization shrinkage stress: current techniques for

posterior direct resin restorations. J Contemp Dent Pract 2006; Sep 1;7(4):79-88.
5- CARVALHO, R. M. et al.: A review of polymerization contraction. The influence of stress development versus stress relief. Oper Dent 1996; 21(1): 17-22.
6- CASTELNUOVO, J; TJAN, A. H. L.; LIU, P: Microleakage of multi-step and simplified-step bonding systems. Am J Dent 1996; 9(6): 245-8.
7- Mount GJ.: Clinical requirements for a successful 'sandwich'--dentine to glass ionomer cement to composite resin. Aust Dent J. 1989; 34(3):259-65.
8- Bala O, Olmez A, Kalayci: Effect of LED and halogen light curing on polymerization of resin-based composites. J Oral Rehabil. 2005; Feb; 32(2):134-40
9- Attar N, Korkmaz Y.: Effect of Two Light-emitting Diode (LED) and One Halogen Curing Light on the Microleakage of Class V Flowable Composite Restorations. J. Contemporary Dental Practices 2007; Feb; 8(2).
10- RODRIGUES S, Silva PIN, MACHADO G, BONA A: Influence of different restorative techniques on marginal seal of class II composite restorations. J Appl Oral Sci. 2010; 18(1):37-43
11- Lawrence W. Stockton, DMD; Susan T. Tsang: Microleakage of Class II Posterior Composite Restorations with Gingival Margins Placed Entirely within Dentin.JCDA 2007; 73(3).
12- Cilli Renato, Prakki Anuradha and Arujo Maria: Microleakage comparison of Class II restorations with flowable composite as a liner: condensable composites versus universal composite. Pos- Grad Rev Fac Odontol Sao Dos Campos 2000; 3(2).
13- Florița1 Z., Romînu1 M., Sinescu1 C., Haiduc1 C., Kigyosi2 A.: The microleakage in open-sandwich class II restorations. European Cells and Materials 2006; Vol. 11. Suppl. 2, (page 23) ISSN 1473-2262
14- Tredwin CJ, Stokes A, Moles DR: Influence of flowable liner and margin location on microleakage of conventional and packable class II resin composites. Oper Dent 2005; Jan-Feb;30(1):32-8
15- Sinval Adalberto, Lúcio Fernando, Giovanna Machado, et al.: Influence of different restorative techniques on marginal seal of class II composite restorations.J Appl Oral Sci. 2010; 18(1):37-43.
16- de Almeida JB, Platt JA, Oshida Y, Moore BK, Cochran MA, Eckert GJ.: Three different methods to evaluate microleakage of packable composites in Class II restorations. Oper Dent. 2003; 28:453-460.
17- Smith ED, Martin FE: Microleakage of glass ionomer/composite resin restorations: a laboratory study. 1. The influence of glass ionomer cement. Aust Dent J. 1992; Feb; 37(1):23-30.
18- Knibbs P.: The clinical performance of a glass polyalkenoate (glass ionomer) cement used in a “sandwich” technique with a composite resin to restore class II cavities. Br Dent J 1992; 172:102-107.
19- Davidsson CL.: Glass ionomer bases under posterior composites. J Esthetic Dent. 1994;6:223-224
20- Tulunoglu O, Uctash M, Alacam A, Omurlu H: Microleakage of light-cured resin and resin-modified glass-ionomer dentin bonding agents applied with co-cure vs pre-cure technique. Oper Dent. 2000; Jul-Aug;25(4):292-8.
21- Barkmeier WW, Cooley RL. Laboratory evaluation of adhesive systems. Oper Dent 1992; Suppl 5:50–61.
22- Hilton TJ, Schwartz, RS, Ferracane JL. Microleakage of four Class II resin composite insertion techniques at intraoral temperature. Quintessence Int 1997; 28(2):135–44.
23- Anusavice KJ. Phillip’s science of dental materials. 10th ed. Philadelphia: WB Saunders Company; 1996.
24- Dietrich T, Losche AC, Losche GM, Roulet JF: Marginal adaptation of direct composite and sandwich restorations in Class II cavities with cervical margins in dentine. J Dent 1999; Aug; 27(6):463-4.
25- Braga R.R., Ferracane J.L.: Alternatives in Polymerization Contraction Stress Management. Crit Rev Oral Biol Med. 2004; 15(3):176-184 (2004)
26- Pilo R, Oelgiesser D, Cardash HS.: A survey of output intensity and potential for depth of cure among light-curing units in clinical use. J Dent 1999; 27: 235-241.
27- Oberholzer TG, Schunemann M, Kidd M.: Effect of LED curing on microleakage and microhardness of Class V resin-based composite restorations. Int Dent J 2004; 54: 15-20.

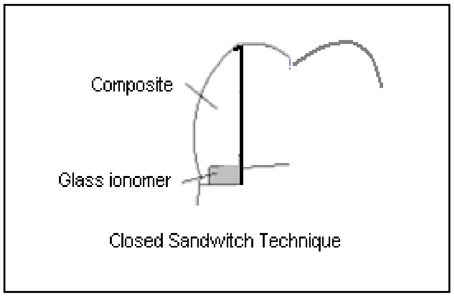

Fig. 1: Closed Sandwich Technique

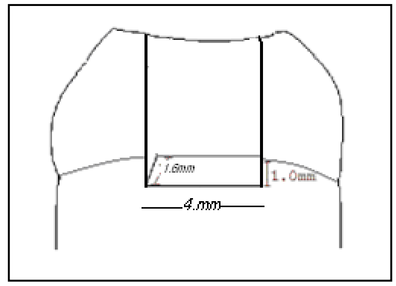

Fig. 2: Dimension of the prepared cavity

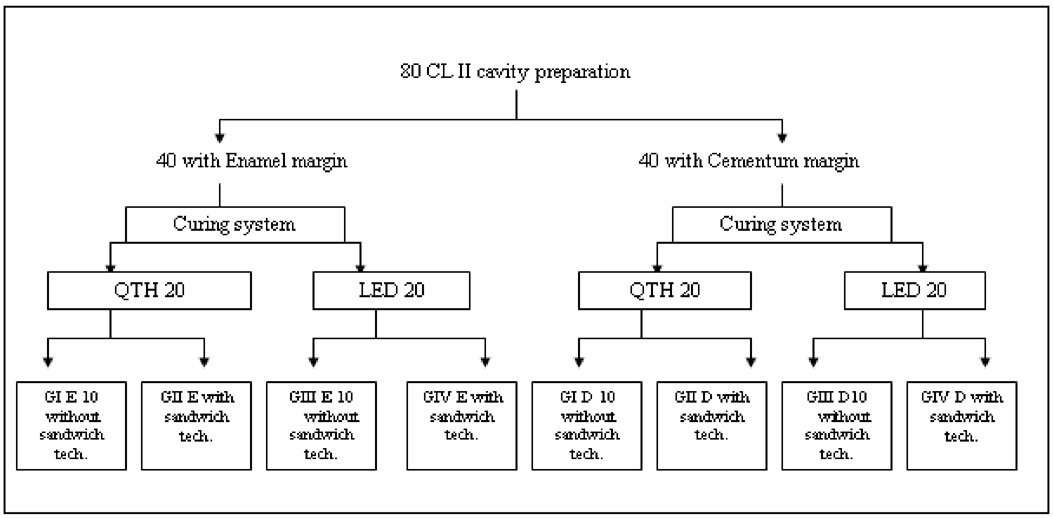

Fig. 3: Grouping of the samples

score	G1E	G2E	G3E	G4E	G1D	G2D	G3D	G4D
0	50%	70%	60%	80%	20%	50%	10%	40%
1	20%	30%	40%	20%	50%	50%	70%	60%
2	30%	0%	0%	0%	20%	0%	20%	0%
3	0%	0%	0%	0%	10%	0%	0%	0%

Table 1: The percentage of scoring of microleakage

Table 2: The descriptive statistic & t-test for microleakage of different substrates

Var.1 / Var.2	Groups	N	Mean	Std. Deviation	t-test	df	Sig
Enamel Gs.	G1E+2E+3E+4E	40	.425	.64	-3.80-	78	.000
Dentin Gs.	G1D+2D+3D+4D	40	1.025	.77			
EGs with out ST.	G1E+3E	20	.600	.75	-2.32-	38	.026
DGs with out ST.	G1D+3D	20	1.150	.75			
EGs with ST.	G2E+4E	20	.250	.44	-1.983-	38	.055
DGs with ST.	G2D+4D	20	.550	.51			

ST. = Sandwich Technique

Table 3:The descriptive statistic & t-test for microleakage with and without sandwich technique

Var.1 / Var.2	Groups	N	Mean	S.D	t-test	df	Sig
With out ST.Gs	G1E+3E+1D+3D	40	.88	.79	3.22	78	.002
With ST.Gs	G2E+4E+2D+4D	40	.40	.49			
EGs with out ST	G1E+3E	20	.60	.75	1.79	38	.082
EGs with ST.	G2E+4E	20	.25	.44			
DGs with out ST.	G1D+3D	20	1.15	.75	2.97	38	.005
DGs with ST.	G2D+4D	20	.55	.51			

Tab. 4: The descriptive statistic & t-test for microleakage with and without LED curing

Var.1 / Var.2	Groups	N	Mean	Std. Deviation	t-test	df	Sig
H.Gs.	G1E+2E+1D+2D	40	.70	.79	.799	78	.427
LED.Gs	G3E+4E+3D+4D	40	.58	.59			
H.Gs. with out ST.	G1E+1D	20	1.00	.92	1.000	38	.324
LED.Gs. with out ST.	G3E+3D	20	.750	.64			
H.Gs. with ST.	G2E+2D	20	.40	.50	.000	38	1.000
LED.Gs. with ST.	G4E+4D	20	.40	.50			