Original Article

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MICROLEAKAGE OF SONIC ACTIVATED COMPOSITE RESIN RESTORATIONS IN CLASS II CAVITIES

Ebaa Alagha[1]

1.Assistant Professor, Restorative Dentistry, AlFarabi Private Colleges, Alharamen Road, Al-Rahmanya District, Jeddah, Saudia Arabia

ABSTRACT:

Aim of the study: This study was conducted to evaluate microleakage of Sonic activated composite resin at different gingival margins in class II restorations.

Materials and method: Ninety freshly extracted molars were selected. The teeth were divided into three main groups (30 each) according to the location of the gingival margin. Group 1: the location of the gingival margin was in the enamel. Group 2: at the cemento-enamel junction. Group 3: in the cementum. Each main group was divided into three subgroups (10 each) according to storage time. Subgroup A: storage time was 24 hours. Subgroup B: storage time was three months. Subgroup C: storage time was six months. Class II cavity was prepared in one proximal surface for each molar following the general principles of cavity preparation. All samples were restored by sonic activated composite (Sonicfill). The specimens were stored in distilled water at 37˚C and a humidity of 100% in an incubator for one day, three months, and three months, respectively, according to the subgroups. After sealing, the samples were stained with 2.5% methylene blue dye. Samples were examined microscopically by a stereomicroscope using a computerized image analysing system. Statistical analysis was done by two-way ANOVA test comparing dye penetration mean values (µm).

Results: The value of dye penetration increased remarkably from enamel, Cemento-enamel junction [CEJ] to cementum, and this was statistically significant ($p < 0.001$).

Conclusion: Sonicfill showed marginal microleakage at different gingival margins. Enamel gingival margin detected the least dye penetration followed by CEJ then cementum.

Keywords: Class II restoration, Micro Leakage, Sonicfill Composite, Gingiva, Enamel, Cemento enamel junction, Cementum

INTRODUCTION:

Composite resin bulk-fill technology has undergone major developments over the last decade [1]. Sonicfill system for posterior restorations has been developed jointly by Kerr and KaVo to get fast and reliable filling technique allowing the reduction of layers, effort and time [2]. The concern regarding bulk-filled restorations, and the reasons why they haven't become standard technique, has historically been related to adaptation to cavity walls, depth of cure, and volumetric shrinkage [3]. Previous researches have shown polymerization shrinkage lead to bond failure and microleakage of resin composite restoration [4]. Microleakage is a matter of concern because it leads to staining at the margins of restorations, recurrent caries, hypersensitivity, and pulpal inflammation [5]. Direct Class II composite restorations can be placed at an acceptable standard if the cervical margin is in sound enamel; when the adhesive restorations are located below the CEJ (cemento-enamel junction) and cervical lesions have no enamel the

*Corresponding Author Address: Dr. Ebaa Alagha. E-mail: drebaaialagha@gmail.com

quality of the marginal integrity is questionable [6]. Although it is not possible to eliminate the shrinkage of the polymeric material, paying attention to minute details, such as making a careful insertion and using an appropriate curing technique, can minimize the stresses resulting from this phenomenon [7].

Figure 1: (SonicFill System)

The aim of this paper is to evaluate microleakage of Sonic activated composite resin at different gingival margins in class II restorations.

MATERIALS AND METHODS:

A total number of ninety human molars were randomly divided into three main groups (30 each) according to the location of the gingival margin. The teeth were cleaned with dental scalers, polished with pumice and stored in a 0.25% mixture of sodium azide in Ringer solution until the date of use. Group 1: the location of the gingival margin was in enamel. Group 2: the location of the gingival margin was in the cemento-enamel junction. Group 3: the location of the gingival margin was in cementum. Each main group was divided into three subgroups (10 each) according to the storage time. Subgroup A: storage time was 24 hours. Subgroup B: storage time was 1 month. Subgroup C: storage time was 3 months (Table 1).

Table (1): Variables of the present study

Class II cavity was prepared in one proximal surface for each molar following the general principles of cavity preparation. The cavities were prepared by using carbide round bur revolving at a high speed with water air spray in the central fossa of each tooth, the bur was changed to carbide tapered fissure bur revolving at a high speed then a carbide inverted cone bur was used to finish the floor of the cavity. The cavities were approximately 4mm in width and 4mm in depth and the gingival margin was about 1.5mm from the axial wall. The depth of the gingival floor was placed according to each group. (group1: in enamel, group2: in CEJ, group3: in cementum). The cavo-surface margins for all walls were without bevels. The cavities were etched with 37% phosphoric acid gel for 15 seconds, according to the manufacturer's instructions. Then, samples were rinsed with water using a plastic syringe for 10 seconds and blot-dried using mini sponges, leaving a moist surface. The total etch (OptiBond Solo Plus) bond was applied by using a fully saturated microbrush with slight agitation to cover the entire surface and was gently air dried approximately 0.5 mm away from the prepared surface for 1-3 second, to allow the solvent to evaporate. The adhesive was then cured using the light curing unit for 20 seconds according to the manufacturer's instructions. Total etch dentin bonding system was used to reduce variability in results that might occurred if some self-etching systems has been used. The intensity of the light cure unit was checked. After placing celluloid matrix band (GoMat, Ivoclar-Viva Dent), SonicFill composite resin (Figure 1) was packed in a single increment (bulkfill technique), after adjusting the dispensing speed at 3 and cured for 20 seconds according to the manufacturer's instruction. After restoration, samples were finished by finishing bur and rubber flame in a low speed hand piece. Specimens were stored in distilled water at 37°C and humidity 100% in an incubator for one day, one month and three months according to each storage interval until microleakage testing. All tooth surfaces except the restoration and 1mm away from the cavity margins was coated with nail varnish then by sticky wax to insure complete sealing of the samples. After sealing, samples were immersed in 2.5% methylene blue dye at 37°C for 24 hours, removed from the dye, cleaned under tap water then left to dry for another 24 hours. Samples were sectioned mesio-distally by using a double-sided diamond disk rotating at a low speed then the crown of each tooth was split longitudinally in two halves by a bi-beveled chisel (Figure 2). Each sample was examined microscopically by a stereomicroscope using a computerized image analyzing system. A digital image of the restoration was captured by a digital camera mounted on a stereomicroscope (Olympus SZ-PT-Japan) at a 25X magnification. Image analysis software was used to measure the linear dye penetration in microns at four different points (cervical, mesio-occlusal, disto-occlusal and at the center of the occlusal surface). Microleakage was measured in microns and the results were statistically analyzed.

RESULTS:

Table (2): Two-way ANOVA test comparing dye penetration mean values (µm) at different locations and storage times.

Figure (2): A bar chart comparing dye penetration mean values (µm) at different locations as a function of storage time.

DISCUSSION:

It is widely believed that microleakage associated with resin composite restorations can be directly linked to marginal integrity [8]. Detection of microleakage can be accomplished with several techniques, including bacteria, chemical or radioactive tracer molecules, fluid permeability, and dye penetration. The most common technique is the use of dyes, the penetration of which is determined after sectioning of the specimen with a magnifying aid [9]. Conventional dye penetration test is the most frequent method used for microleakage evaluation because of its simplicity [10]. Methylene blue (0.2- 2%) is commonly used as dye-penetration solution [11]. Most of the microleakage studies are done in-vitro [12]. It is an established method for the determination of marginal leakage mostly performed after cutting the teeth in a longitudinal direction [13]. In-vitro studies isolation and access to cavity are not difficult. In clinical situations the access to the site is not easy. This is especially difficult when the cavities were made for the study purposes in which the dimensions of the cavities had to be controlled for standardization. Also, in proximal restorations adhesives are also not easy to be used. The contributory factors are the difficult accessibility of the corners of the deep proximal box; the adherence of materials to metal matrix bands, which creates a potentially higher C factor; and air drying, which may produce air voids within the hybrid layer during the process of solvent removal [14].

Figure (3): A sample after sectioning longitudinally

Class II cavities involving dentin has been studied by numerous authors [15-19]. The location of the cervical margin in dentin, have a determining factor for the longevity of restorations, the occurrence of infiltration by marginal leakage [20, 21]. In an attempt to minimize problems inherent restorations have appeared in numerous market restorative materials with physical and mechanical properties seeking to better dissipate stress, thereby causing a lower leakage [22]. The majority of Class II cavities exhibit cavity margins with gingival wall below the CEJ in both dentine and/or cementum [23]. Therefore, the cervical margins of restorations will be placed at dentine or cementum surfaces, which may lead to a weaker marginal seal than at the enamel surface [24]. Class II cavities were confectioned only in one part of the teeth, since the photo-curing of the resin restoration could influence the shrinkage stress generation on the restoration of the other side [25]. SonicFill was used in this study to increase the ease and efficiency of posterior composite placement. This composite resin can deliver an aesthetic composite restoration in one true "bulk fill" increment. It has a less polymerization shrinkage with high viscosity and high depth of cure (5 mm) as claimed by the manufacturer [26]. OptiBond Solo Plus adhesive system was used as the etch-and-rinse adhesive systems provide bonding to both enamel and dentin has proven clinical effectiveness with consistent long-term results [27].

In this study, statistically significant difference was observed when enamel and dentin margins were compared. All dentin margins had inferior results compared to enamel margins. This variation may be due to the variation between the substrate [28]. Bonding to dentin has continued to be a challenge [29]. Part of the challenge in bonding to dentin when compared to enamel is the difference in the substrates. Enamel is homogeneous in nature and is primarily composed of hydroxyapatite. Etchants dissolve hydroxyapatite crystals in enamel, creating pits by which the adhesive resin is readily absorbed by capillary attraction, creating macrotags of resin that envelop the individually exposed hydroxyapatite crystals. Additionally, resin microtags extend within tiny etch pits in the enamel prism cores [29]. Resin tags in the interprismatic spaces provide for the majority of micromechanical adhesion [30]. In comparison, dentin is heterogeneous, consisting of hydroxyapatite and collagen. The degree of mineral content in dentin is quite variable, depending on whether it is near the dentino-enamel junction or deeper in close proximity to the pulp [27]. Overall, the water content of dentin is significantly higher than enamel, posing another challenge to adhesive bonding [29]. The acid conditioning of dentin leaves a micro-porous scaffold of collagen fibrils after most or all the hydroxyapatite is eliminated. Adhesive resin microtags infiltrate and mechanically interlock within this micro retentive collagen network [29]. Also in the gingival areas the direction of the tubules is almost horizontal and mechanical bonding through resin penetration into dentinal tubules is negligible. Other factors that affect the marginal seal are contraction of the composite material, stresses at tooth-restoration interface, stiffness and other mechanical properties of composite.

Usually bond between enamel and composite survive these stresses while failures are observed at composite-dentin or composite-cementum interfaces [31]. It has been shown that when the gingival margin is placed below the cemento-enamel junction, an outer layer of cementum provides a hypo-mineralized and hyper-organic substrate for bonding. This tissue even after etching does not provide the adequate conditions for the micro-mechanical retention of an adhesive material [32]. This was in agreement with the present study.

The high dye penetration values may be attributed to the location of restorations. Stockton in his study of microleakage in deep proximal cavities demonstrated that despite more favourable conditions, moderate to considerable amounts of leakage occurred with all methods of composite restoration. His study was an in-vitro where moisture control and cavity access were easier to achieve as compared to working intra-orally but none of the methods could give absolute seal [33]. Moreover, the success of composite restorations depends on the adhesion of restorative materials to hard tooth tissue. The dental adhesives have different tooth composite interface morphologies, different bond strengths and different abilities in microleakage prevention [34]. If poor bond strength exists between the tooth and restorative material, failure of adhesion and microscopic gaps at the tooth/restoration interface can subsequently form and microleakage happened [35]. The adhesion between composites and dentin is not as strong as with enamel. Also, the difference in thermal expansion between dentin and composite is larger than the difference between enamel and composite. This difference may be an additional contributing factor to the increased leakage at the dentin margins. Therefore, the material can be dislodged, causing a bad adaptation of the restoration to the gingival margin. This finding was in agreement with other studies [36]. In addition, below the CEJ the bond with dentin is weaker: the polymerization shrinkage can result in gap formation between composite resin and the cavity walls [24]. In this study, least dye penetration was found at 1 month storage time then at 3 months then at 1 day. This may be explained by the water sorption potential of composite resins. Storage of the specimens for 1 month would allow some water sorption by the resin and subsequent hygroscopic expansion of the restoration. This expansion would not establish a perfect marginal seal but could contribute to less dye penetration. Conversely, 24 hours would not permit the time necessary for this phenomenon to occur [37]. This was in agreement with YAP and Wang H [38], as they found a significant decrease in marginal gaps between 1 day and 1 week and they found that all materials showed a decrease in gap width within 1 week storage in water. This result appear to support the results obtained with Momal and McCabe [39] who concluded that expansion caused by water sorption is able to rapidly compensate the effects of polymerization shrinkage. On the other hand, Davidson and Feilzer [40] are of the opinion that the water sorption is a slow process and its compensatory effects for polymerization shrinkage often come too late.

It is important to note that the amount or rate of water sorption and compensation is a product specific and may be dependent on the chemistry of the resin matrix [41]. Li H and Burrow M [42] found that a minimum of 1 year of storage in water is necessary to correctly evaluate its effect on microleakage. A significant improvement of the marginal sealing was observed by Carlos Torres and Maria de Araujo [43] at 6 months in comparison to base line. This may be attributed to the water sorption by composite resin which expand hygroscopically and contribute to closing marginal gaps. Youngson C and Jones J [44] noticed that marginal microleakage decreased after the second or fourth week in water storage. These results were in agreement with the present study.

CONCLUSION:

Under the conditions of this in vitro study, it can be concluded that the marginal microleakage values were influenced by the different gingival margins.

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TABLES:

Table (1): Variables of the present study

Variable design	Symbol	Referring to
Gingival margin	G 1	Gingival margin at enamel
	G 2	Gingival margin at CEJ
	G 3	Gingival margin at cementum
Storage time	S 1	1 Day
	S 2	1 Month
	S 3	3 Months

Table (2): Two-way ANOVA test comparing dye penetration mean values (µm) at different locations and storage times.

Source of Variation	*Df*	*Sum-of-squares*	*Mean square*	*F*	*P value*	*Sig.?*
Margin site	2	2538000	1269000	8.335	0.0027	Yes
Storage time	2	3954000	1977000	12.98	0.0003	Yes
Residual	18	2741000	152300			

FIGURES:

Figure (1): SonicFill system

Figure (2): A bar chart comparing dye penetration mean values (µm) at different locations as a function of storage time.

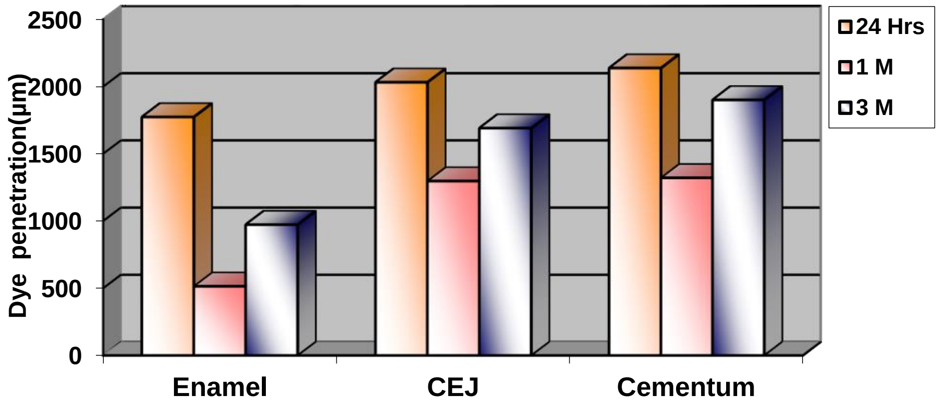

Figure (3): A sample after sectioning longitudinally