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Microleakage of composite and porcelain laminate restorations: an *in vitro* study

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Abstract
Our aim in this study is; To compare the microleakage of composite and porcelain laminate restorations in *in vitro* conditions.
In this study, 30 non-carious anterior teeth were used. After restorations were completed, were polished with polishing rubbers, They were kept in 37 ° C distilled water for 24 hours. After thermal cycle process, the entire tooth surface was covered with nail polish, 1mm away from the restoration border. Teeth were kept in a 0.5% basic fuchsin liquid for 24 hours in an oven at 37°C. The sections obtained were scored. Leakage values on the sectional surfaces obtained were examined under a stereo microscope at 25X magnification and scores were recorded. Statistical analysis of the micro leakage test were evaluated Wilcoxon test. When leak scores were compared according to all surfaces, there was no statistically significant difference between the materials ($p = 0.05$, $p > 0.05$).

Keywords: Microleakage, composite, porcelain

Introduction

Buonocore explained the acidification of the enamel with liquid solution in liquid form in 1955 and the formation of resin tags with the penetration of resin monomers into the resulting microporosities and the formation of a micromechanical bond after polymerization. The enamel binding technique has become standard and accepted, and problems with dentin binding have been experienced. However, with the development of various bonding systems, there has been a significant improvement in binding to dentine [1]. Dental adhesives have many classifications in the scientific literature. Functional based classification; It is presented to contain three main groups of adhesives: total-etch or etch and rinse adhesives, self-etch adhesives and glass-ionomer adhesives [2].

The efficacy and success of the roughened enamel / resin linkage has been demonstrated in many clinical trials [3]. The use of adhesives has now become routine in the placement of sealents [4]. The clinical success of the enamel adhesive technique, which is used in conjunction with protective resin restorations in less invasive cavity preparations to restore carious pits and fissures, has been documented [5, 6]. It has been shown that all anterior preparations are restored with enamel adhesive technique and composite resin [7]. Suspected posterior composites, on the other hand, have been reported to have a clinically successful life of 10-15 years, and those that have been roughened and restored with acid have been reported to be an alternative to amalgam in non-oversized cavities [8, 9]. The main test of enamel attachment is the placing of thin and fragile porcelain veneers on the facial surfaces of the anterior and posterior teeth. A nearly 20-year clinical evaluation found that porcelain veneers produced by Cerinate Porcelain (Den-Mat) showed 93% success, meaning 15.2 years [10]. In fact, it was seen that veneers did not leave during the study. This study is in line with Friedman's retrospective study. In this study, approximately 3500 restorations were evaluated and 245 failed restorations were detected. The success rate in this research is 93% again. The margins of the failed veneers were found to be covered with dentin [11].

When PLVs were first developed in the 1980s, the physical properties of the materials and binder systems used increased the likelihood of failure, along with some unknown in the porcelain interface with adhesive resin. With the disappearance of the bonding power problem, it causes fractures. possible occlusion problems; Topics such as periodontal problems affecting early and long-term success and edge discolouration caused by microleakage at the tooth-porcelain interface have begun to be addressed [12].

Our aim in this study is; To compare the microleakage of composite and porcelain laminate restorations in *in vitro* conditions. In this study, our hypothesis is; that composite laminate restorations in *in vitro* conditions show higher microleakage than porcelain laminate restorations.

Materials and methods

In this part of the study, 30 non-carious anterior teeth were used. Soft attachments on the teeth were cleaned with a brush. After restorations were completed, were corrected with polishing rubbers, they were kept in 37 ° C distilled water in an oven in a dark environment for 24 hours.

Prior to microleakage, samples of all groups were applied thermal cycles 500 times between water baths (core sec. Mal. Manufacturing and Tic. Inc., Turkey) 5°C (± 1 °C) to 55 °C (± 1 ° C) 500 x. After thermal cycle process, the entire tooth surface was covered with nail polish, 1mm away from the restoration border, in order to avoid paint penetration from areas other than restoration. After drying, the second coat of nail polish was applied. The apex of the teeth was closed with composite resin. Teeth were kept in a 0.5% basic fuchsin liquid for 24 hours in an oven at 37°C. The samples removed from the oven after 24 hours were washed under running water for 10 minutes and excess paint removed. The root part of the teeth was separated with Isomet device 2mm below the enamel-cement border with the help of a diamond separator. Then, in Isomet device, it was divided into two in the mesio-distal direction with a diamond separator. The sections obtained were scored.

Cross section surfaces were examined and scored in two regions as cervical and palatinal regions. Leakage values on the sectional surfaces obtained were examined under a stereo microscope at 25X magnification and scores were recorded. In order to evaluate the dye penetration in both regions, measurements were made separately from the arm and incision. The cole and the incisal region were scored separately and scored 1 to 5. Dye penetration scores for leakage are shown below (Figure 1). (The score "0" means "no dye penetration."). Statistical analysis of the micro leakage test were evaluated Wilcoxon test.

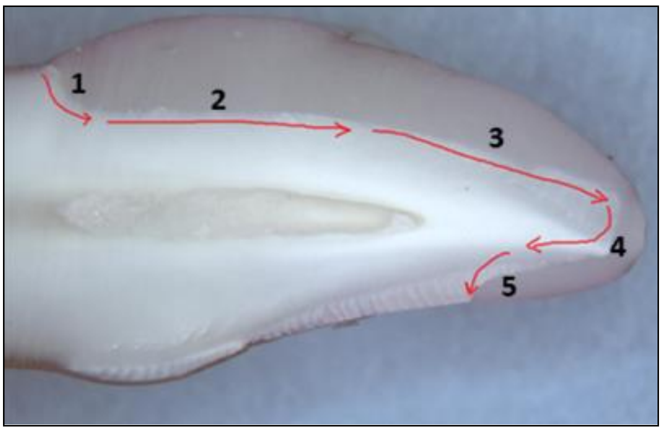

Fig 1: Microleakage score.

Results

Average leakage values obtained by evaluating the micro leaks are shown in Table 1 and graphically in Figure 2.

According to the data obtained, whether there is a difference between the groups was evaluated statistically with Kruskall-Wallis test. When the leakage scores of the materials were compared with respect to the cole surface, there was no difference between the materials in terms of leakage ($p = 0.096$, $p > 0.05$). When leak scores were compared according to the palatinal surface, there was no statistically significant difference between the materials ($p = 0.05$, $p > 0.05$). When the materials were evaluated separately, leak scores were not significant according to the surfaces ($p > 0.05$; Wilcoxon sign test). The examples of the leak rating system are shown below with x10 magnification (Figure 3, 4).

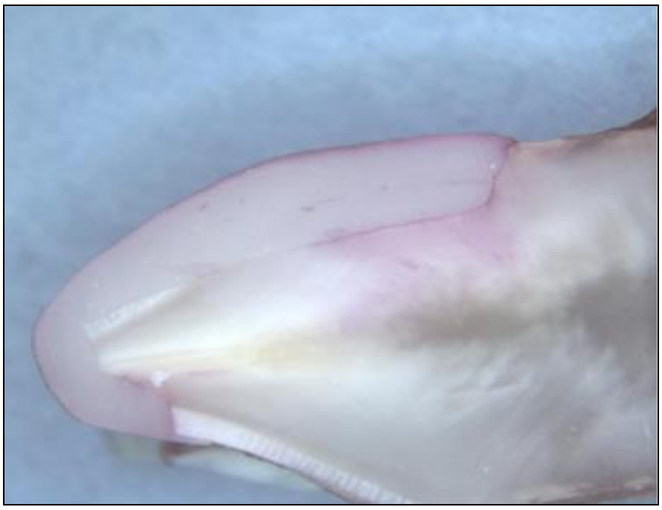

Fig 3: An example of the microleakage scoring system (Aelite). Buccal 2, palatinal 1 (x10 magnification).

Fig 4: An example of the microleakage scoring system (E max). Buccal 0, palatinal 1 (x10 magnification).

Discussion

In vitro and in vivo methods are used to determine edge leakage. In vivo methods are the visible state of the edges of the existing restoration, color change, radiological image and control of the area with the help of a sond. *In vitro* methods are; It is the determination of the leakage of dyes, chemical markers, radioisotopes, bacteria or compressed air to the outer filling interface with the help of stereomicroscope and SEM [13]. In many edge leakage studies, basic fuchsin dye penetration method has been used to determine the edge leakage [14, 15]. With this cheap and simple method, it is observed whether there is a leak or not, and at the same time, the performance of various restorations are determined and compared [16]. Although some researchers [17] argue that leak detection and classification will be easy with the use of basic concentrations such as 2%, basic fuchsin is commonly used at a concentration of 0.5% [18, 19, 20].

In his study, Gonzales [21] stated that the basic fuchsia of 0.5%

is the dye that shows the most leakage amount [22]. For this reason, in our study, the basic fuchsin dye penetration method of 0.5% concentration was preferred in determining the edge leakage. According to a study by Aboushelib *et al.* [23], the most marginal interval was observed in incisal and cervical regions in CAD-CAM porcelain laminate restorations. In addition, restorations with adequate marginal compliance according to CAD-CAM technology may not provide adequate internal compliance [24]. Reich *et al.* [25] reported that in systems that depend on optical size, problems occurring at the resolution during scanning may show elevations or tapering around the edges of the preparation. In aesthetic restorations such as laminate restorations, microleakage is an important error that may require the restoration to be renewed [26]. Factors such as the area where the restoration edge is located, polymerization method, adhesive resin type, finish line and preparation type are factors that should be taken into consideration in reducing the microstructure in porcelain laminate restorations [27-30]. In addition, Aboushelib *et al.* [23] showed that pourable porcelain veneers are more resistant to micro-leakage with higher marginal compatibility, more homogeneous and thin film thickness than CAD-CAM porcelain laminate restorations [23]. If the edges of the restorations are not closed completely, edge leakage may occur and accordingly, caries and tooth sensitivity may occur under restoration [31, 32].

In this study, All Bond Se with Aelite composite were preferred. In some studies, composites perform similarly in terms of leakage [33-36]. Therefore, at the end of this study, we think that there is no difference between the two materials in terms of leakage because the adhesive systems used with them have similar properties.

IPS E.max showed a 5 score in a single sample. For two reasons, the leak seems clinically insignificant: first, the average microleakage in the dentin and enamel is acceptable, and secondly, the leak detection method cannot distinguish smaller micrometric differences.

Pressable porcelain laminate restorations CAD-CAM has higher marginal adaptation, homogeneity, thinner cement film thickness and less microleakage than porcelain laminate restorations [23]. In one study, composite resin and porcelain laminate restorations were examined in terms of edge compatibility. At the end of the analysis, it was observed that more gaps were formed in the porcelain laminate restoration compared to composite resin. This may be due to the difficulty of making porcelain inlays. In order to achieve healthier results, the number of samples should be increased.

Kunzelmann and Hickel [37] observed a deterioration in the margins of porcelain restorations in their study. The reason for this is shown the leucite material contained in the ceramic. The cement film thickness under the restoration is directly related to the internal marginal fit and the production stage of the porcelain. In a study by Hekimoglu *et al.* [29], incisal microleakage was found to be higher in overlap laminate restorations than window type veneers. Although there is no statistical difference in this study, the reason for the high leakage in IPS E.max may be the incompatibility of CAD-CAM porcelains with the overlap preparation.

There was no significant difference between the microleakage of the composite and porcelain laminate restoration samples in the incisal and palatinal regions.

Conclusion

Despite the limitations of this study, no difference was found in terms of microleakage in composite and porcelain laminate restorations. This result shows that adhesive systems and adhesive cements that provide the connection of composites and porcelains in this study have similar properties in preventing microleakage.

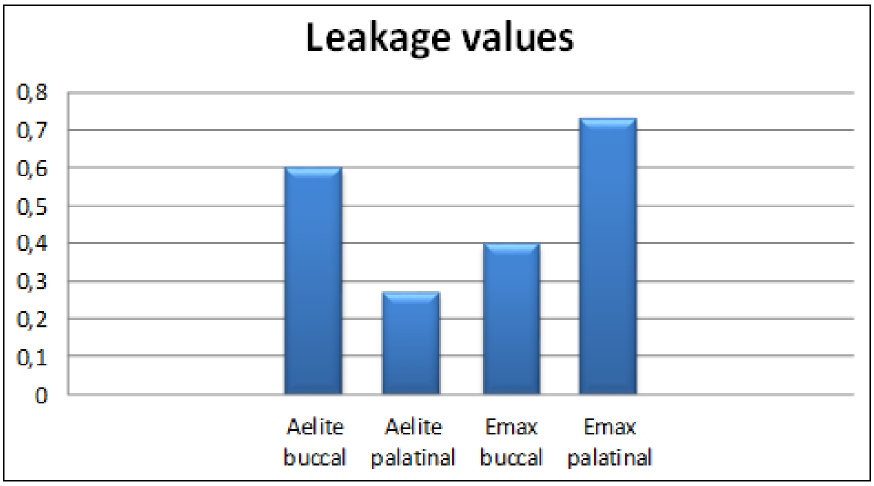

Fig 5: Medium microleakage values.

Table 1: Microleakage values

Materials	Bölge	Microleakage						
		n	0	1	2	3	4	5
Aelite	Buccal	15	7	7	1	0	0	0
	Palatinal	15	11	4	0	0	0	0
Emax	Buccal	15	9	6	0	0	0	0
	Palatinal	15	8	6	0	0	0	1

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