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Microleakage Evaluation of Standard and Expired Composites and Bonding Agents at the Dentin-Resin Interface

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ABSTRACT

Introduction: For a restoration to be successful, one of the key properties of the material is to prevent micro leakage. Even though shelf life of composite resin and bonding agent in an important factor, they can be used for simple procedures even after their expiration date. The aim of the study was to determine the effect on micro leakage of standard and one-year expired composites and bonding agents.

Materials and Methods: Selected forty specimens were etched for 15 seconds in 37 percent phosphoric acid and randomly divided into four groups: Non-Expired composite and bonding agent; Expired composite and bonding agents; Non-Expired composite and expired bonding agent; Expired composite and Non-Expired bonding agent; and Expired composite and Non-Expired bonding agent. Using a stereomicroscope, specimens were sectioned longitudinally and examined for leakage (dye penetration).

Results: The results of the present study indicated significant differences in micro leakage scores between group 1 and group 2. Mann-Whitney U test showed that all the four groups are statistically non-significant so there is no statistically significant difference between any two groups.

Conclusion: These findings of the study indicated that expired composites and bonding agents showed acceptable values in terms of micro leakage.

Key words: Expired composite resin, Micro leakage, Expired bonding agent, Dentistry

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INTRODUCTION

Essentially polymeric materials, restorative composites work better in vitro and in vivo depending on the chemical structural configuration, the rate of deterioration over time and other factors [1]. The deterioration of resin composites is a multifaceted, complex process. Two main types of degradation can be seen extra oral deterioration brought on by the storage of the substance and its shelf life, and intraoral degradation (mechanical, physical, or chemical). Many of the materials used in dentistry must be stored in a certain way to preserve their optimal characteristics and lengthen their shelf life.

A mixture of impacts from oxidative chain scission, oxidation hydrolysis, changes in crystallinity, and other variables that may be reliant on the environmental storage may result in the degradation, which may be mostly chemical in nature [2].

The batch number, the expiration date, and the storage instructions are printed on the box of each syringe of composite that a dentist purchases. The shelf life of the majority of direct composite restoratives is short. The shelf life of a material is defined by the American National Standards Institute (ANSI) as the amount of time (counting from the date of manufacturing) during which a material maintains the physical and mechanical attributes required to fulfill its intended purpose [3].

Between uses, dental supplies are stored on a shelf or in the refrigerator for extended periods of time. The components of the material must thus not separate, evaporate, react, or degrade during this time when it is no longer in use [4].

Materials made of resin need to be stored carefully to keep their full efficiency.

Typically, a temperature range of 4°C and 20°C is advised. However, because resin composite storage requirements might vary depending on the geographic and climatic parameters (sun exposure and humidity) of the country, the majority of dental manufacturers advise refrigerated resin composite storage.

When not in use, chemically- and dual-cured composites should be kept in the refrigerator, and they should be given at least one hour to acclimate to room temperature. When stored in a cold environment, the auto cured component of dual composites has a shelf life of around 18 to 24 months. However, these composites have a reduced lifespan when stored at room temperature. Contrarily, light-cured composites have a predicted shelf life of roughly 5 years since they are stable at room temperature if kept sealed to prevent monomer evaporation [5].

Investigated was the impact of unsupervised outdoor storage in a variety of environments. Chemically-cured composites appear to be more susceptible to the effects of storage than light-cured composites [6, 7]. The storage stability of restorative dental biomaterials has been the subject of several investigations that have been published [8-13].

One crucial aspect to take into account is the resin composite's expiration date. The material qualities might theoretically change if utilised past the given expiration date. Clinically speaking, this could result in failures such fracture, excessive wear, and discoloration. Dentists can use some resin composites past the manufacturer's indicated expiration date in their routine care. Should they throw away those materials or can they use them for a brief time?

NULL HYPOTHESIS

The study is conducted with a null hypothesis stating that micro leakage seen in one year expired composite and bonding agent would be significantly higher than that seen in non-expired composite and bonding agent.

MATERIALS AND METHOD

This study was conducted in the Department of Conservative Dentistry and Endodontics, after obtaining Institutional Ethical Committee Approval. Forty, recently extracted human permanent molars, which were extracted for periodontal reasons were included. The exclusion criteria were: presence of any caries, old restorations, cracks, or hypo plastic defects. The teeth were then cleaned with ultrasonic instruments. They were then classified into four categories based on the composite and bonding agent used

Group 1: Non-Expired composite and Non-Expired bonding agent

Group 2: One year Expired composite and expired bonding agent

Group 3: Non-Expired composite and one year expired bonding agent

Group 4: One year Expired composite and Non-Expired bonding agent.

Cavity Preparation

Class I cavities were prepared by using straight fissure bur GW557, SS White, New Jersy), with a high-speed hand piece. The dimensions of the cavity were kept as follows length: 3 mm, width: 2 mm and depth: 3 mm. Copious amount of water was used as a coolant. The cavities were then rinsed with a water spray. Dentin of the prepared cavity wall was etched with 37 percent phosphoric acid for 15 seconds. The etching gel was then sprayed away with water for 10 seconds. The bonding agent (Ivoclar Vivadent, USA) was applied per the manufacturer's instructions. The cavity was then filled with composite Tetric N Ceram A2 (Ivoclar Vivadent, USA) in 2 increments and cured after placing each increment. The restoration was finished and polished using polishing discs.

Oral conditions were simulated by placing the specimens in distilled water bath at 37°C for 24 hours followed by thermo cycling them for 500 cycles between water baths held at 5°C and 55°C with a 30-second dwell time in each bath with a transfer time of 2 seconds.

The teeth were then dried and sealed with nail varnish. The varnish was kept 1 mm short of the restoration margins. The varnish coated teeth were then immersed in a 2% methylene blue solution for 24 hours. The samples were then removed from the die were washed with water. They were then sectioned through the centre of

Table 1: Mean and Standard Deviation (SD) of micro leakage using Kruskal-Wallis test.

Micro leakage		
Groups	**Mean**	**SD**
I	1.1	0.994
II	1.6	0.843
III	1.3	0.949
IV	1.4	0.966
P VALUE	0.63	

Table 2: Intergroup comparison of groups for micro leakage scores using Mann-Whitney U test.

Composites	Micro leakage
Normal composite vs expired composite	34
Normal composite vs normal composite expired	43.5
Normal composite vs expired composite normal	40.5
Expired composite vs normal composite expired	40
Expired composite vs expired composite normal	44
Normal composite expired bonding agent vs expired composite normal bonding agent	46.5

the restorations in a bucco-lingual direction using a slow-speed straight hand piece and D+Z diamond disc. Finally, using a stereomicroscope, they were visually examined for dye penetration along cavity walls. (Olympus at a magnification of × 40).

For measurement of micro leakage, a scoring system was used as [14]

0- no dye penetration;

1- dye penetration into half extension of the cavity wall;

2- dye penetration into more than half or complete extension of the cavity wall;

3- dye penetration into the pulpal floor.

RESULTS

The micro leakage exhibited by the samples as seen in the stereomicroscope (40X) along with the scoring criteria. Table 1 shows the mean value ± standard deviation of micro leakage scores for all the groups with maximum micro leakage for one year expired composite and expired bonding agent and minimum micro leakage for non-expired composite and non-expired bonding agent. Kruskal-Wallis test indicates statistically non-significant values of micro leakage among all the groups with a p-value of 0.630 [Table 1].

The results of the microscopic examination revealed no marked difference in dye penetration between the groups. For intergroup comparison, Mann-Whitney U test [Table 2] was applied which shows that all the four groups are statistically non-significant so there is no significant difference between any two groups.

Thus, this study evaluated that the degree of micro leakage in descending score is as follows

Group II (mean score of micro leakage 1.6) > Group IV(mean score of micro leakage 1.4) > GroupIII(mean score of micro leakage 1.3) > Group I(mean score of micro leakage 1.1).

DISCUSSION

Composites have been widely used in recent decades due to their aesthetic qualities. However, related issues, such as micro leakage and postoperative sensitivity, persist and cause doctors to be confused about its application in a variety of situations. All of these problems are said to be linked to traditional composites. As a result, it is reasonable to assume that using one year expired composites will worsen these qualities even further. Despite of composites being expired, the higher cost of this material forces dentists to use it despite the risks. The attributes of expired composites and bonding agents were therefore studied and compared with those of the standard composite in various combinations, with an emphasis on the amount of usage of expired composites, taking into consideration the great popularity of this extravagant material.

Micro leakage can be assessed using various techniques, die penetration being the most commonly used as it is inexpensive and easy to use. Various dies such as methylene blue, basic fuchsine, erythrosine can be used to study micro leakage. The most commonly used organic die is Methylene blue in the concentration ranging from 0.5% to 5% as it is easily available, easy

to handle, inexpensive had has a high degree of staining [15].

On intergroup comparison, the micro leakage scores were significant between the normal and the one year expired composites and bonding agents. All the four groups are statistically non-significant so there is no statistically significant difference between any two groups. The shift in micro leakage of expired composite might be explained by partial polymer cure, which could be caused by the breakdown of the components involved in the polymerization of this material over time [16].

Soderholm KJ, et al. [17] discovered that ion leakage into the uncured monomer causes a reduction in the filler particles of restorative composites held in liquid medium for particular durations of time. This is regulated by the photo initiator concentration, which declines throughout the material's shelf life. For example, if the silane coupling agent has deteriorated, a composite may wear out faster than intended [18].

There are numerous and diverse methods by which composite resins can deteriorate in the oral cavity, which are now recognized as a complex interplay of interactions.

There is rising concern about the safe clinical usage of these materials due to their biodegradation in the oral environment.

Biodegradation is caused by a variety of factors, including saliva characteristics, chewing, thermal, and chemical dietary changes.

According to visible light-cured composite may preserve particular physical features for up to 7 years. Although it is not recommended to use expired dental materials, the qualities of the material altered by ageing are yet unclear. Although we advocate for extending the shelf life of these pricey materials, the extent to which they may be utilised effectively after their expiry date should be established by more study, as well as the evaluation of other desired features. Another study done by Ferracane JL, failed to report any notable changes in the hardness and water sorption of six moth old composite when compared with standard composite [19].

CONCLUSION

Current findings of the study indicated that expired composites and bonding agents showed acceptable values in terms of micro leakage. Despite the fact that composite has the best properties when it is not expired, expired composite Tetric N Ceram (Ivoclar Vivadent) with standard Tetric N Bond (Ivoclar Vivadent) agent can be used in clinical situations when availability is questionable.

Clinical Significance of the study

The expiration date of a resin composite is an important consideration. Material qualities may be affected if utilised after the specified expiration date. Clinically, this may result in failures such as fracture, excessive wear, and discoloration. When not in use, chemically and dual-cured composites should be refrigerated and allowed to come to room temperature for at least 1 hour before use. For a better understanding of the effect of the expiration date on resin-based materials, other properties with clinical implications such as working duration, consistency, and effect of ambient light should be explored.

Limitations of the study

Mechanical loading, salivary characteristics were not undertaken in this study as different findings may have been found if the restorations had experienced occlusal stresses from masticatory loading. Another disadvantage of this study was that specimens were only evaluated using a stereomicroscope.

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Conflicts of Interest

There are no conflicts of Interest.

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