The influence of two chelating agents used in two different working times on the microleakage of packable composite resin used in post space (in vitro study)

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ABSTRACT

Background: Weakened teeth are not strengthened by the placement of a post but retention of restoration is enhanced by using a post. Restoration with adhesive materials offers many advantages over the use of traditional materials, like transmission of functional stresses across the bonded interface to the periodontium, with potential to reinforce the weakened tooth structure. Cavity preparation and root canal instrumentation leave a layer of debris that covers the walls of the cavity and root canal, known as smear which can be removed with a chelating agent. This in vitro study conducted to evaluate the effect of two different chelating agents used in two different times of application on the microleakage of packable composite resin (Filtek P60 shade) used in post space.

Materials and method: Fifty, human, freshly-extracted mandibular premolars were selected. After crown sectioning and conventional endodontic treatment, parallel post spaces 5mm in depth and 2mm in diameter were prepared using perso burs (LARGO No.6). Then the specimens were randomly divided into five groups as follow: Group1 (control): The post space was filled with packable composite without previous using of chelating agent. Group2 (experimental): The post space was flooded with 17% EDTA for 5 minutes prior filling with packable composite. Group3 (experimental): The post space was flooded with 10% citric acid for 5 minutes prior filling with packable composite. Group4 (experimental): The post space was flooded with 17% EDTA for 10 minutes prior filling with packable composite. Group5 (experimental): The post space was flooded with 10% citric acid for 10 minutes prior filling with packable composite. After thermocycling and immersion in methylene blue, the teeth were sectioned longitudinally and dye penetration was evaluated using a stereomicroscope, microleakage was recorded in mm.

Results: ANOVA test and least significant difference (LSD) test were used to analyze the results and to show the difference between groups. Results expressed statistically highly significant reduction in microleakage value among all groups; with the lowest mean microleakage value was in group5 in which citric acid was used for 10 min., followed by group4 in which EDTA was used for 10 min., followed by group3 in which citric acid was used for 5 min., followed by group2 in which EDTA was used for 5 min., and control group showed the highest microleakage value.

Conclusion: From the results of the present study, it is clear that the application of a chelating agent prior using acid etch and adhesive system with composite resin filling material will significantly reduce microleakage value of the restorative material.

Key words: Microleakage, Packable composite, Post, Chelating agent.

INTRODUCTION

Great number of endodontically treated teeth is lost because of fracture caused by improper restoration than because of poor endodontic treatment. In recent years, the choice of materials use in the restoration of endodontically treated teeth has changed from exclusive use of very rigid materials to other materials which have mechanical characteristics that more closely resemble dentine (1). Weakened teeth are not strengthened by the placement of the post but retention of restoration is enhanced by using a post. It is thought that filling the post space with composites and dentine bonding agents may produce superior adaptation to the dentinal wall (2). The introduction of packable composite has brought great improvements in the treatment modality of endodontically treated teeth (3). These resin based materials have become widely accepted as restorative materials for these teeth. Restoration with adhesive materials offers many advantages over the use of traditional materials, like transmission of functional stresses across the bonded interface to the periodontium, with potential to reinforce the weakened tooth structure (4).

T jan et al. found that the retentive value of the composite reinforcement bounded to the root canal wall was statistically higher than that of a custom cast post luted to the root canal wall with zinc phosphate cement.

Cavity preparation and root canal instrumentation leave a layer of debris that covers the walls of the cavity and root canal, known as smear layer (5). The layer is composed of organic and inorganic components and, in cases of contamination, a bacterial component. The
removal of smear layer requires organic and inorganic solvents\(^6\).

The smear layer was first described in endodontics by McComb & Smith (1975), who removed it with a chelating agent. The most widely used demineralizing agents are citric acid (at different concentrations) and EDTA trisodium salt (15-17% consternations)\(^5\).

So this study is going to evaluate the effect of using 17% EDTA and 10% citric acid in 5 and 10 minutes of application for each on the microleakage of packable composite.

**MATERIALS AND METHODS**

Fifty freshly extracted mandibular premolars teeth were selected for the study and checked for cracks and root resorptions. All crowns of the teeth sectioned approximately at the cemento-enamel junction using slow speed hand piece (Kavo, Germany) with diamond separating discs (Dentarum, UK) and normal saline for cooling. After conventional debridement, mechanical preparation was made using step back technique using K-files (densply/ maillefer, ballaigues, switzerland). Filling procedures were made using lateral condensation technique, the canals were fitted with a size 50 master cone gutta percha (GAPADENT Co., Ltd, Germany) and Apexit plus sealer (Ivocalr-Vivadent, Schaan, Leichtensein). Parallel post spaces were prepared to 5mm depth and 2mm diameter using pesso burs (LARGO No.6), and dental surveyor (Cendres & Metaux).

The prepared teeth were assigned randomly to five equal groups: **Group 1** (control): The post space was filled with packable composite without previous using of 17% EDTA or 10% citric acid in which the prepared post spaces were etched with phosphoric acid (Scotchbond, 35% phosphoric acid, 3M ESPE, USA) for 15 seconds, rinsed with water, and air dried with air syringe for 20 seconds. Adhesive (Adper Single Bond, 3M ESPE, USA) was applied to the etched surface for 30 seconds and light polymerized for 20 seconds (Dentsply, Type: Halogen light, Light intensity: 400mW/mm). Using plastic instruments, Packable composite (Filtek P60, shadeA3, 3M ESPE, USA) condensed as one bulk in the post space over the table of a balance. The force used in condensation corresponded to 3kg by weight (to achieve standardized force for condensation). The excess composite material was removed, after which a microscope slide cover (Matsunami Glass, Japan) placed over the specimen (to get a smooth flat surface). The packable composite was light polymerized for 40 sec prior to removal of microscope slide cover.

All the other groups were restored in the same procedure, except that: **Group 2** (experimental): The post space was flooded with 17% EDTA for 5 minutes then washed out with 5 ml of normal saline prior to filling the post space with packable composite. **Group 3** (experimental): The post space was flooded with 10% citric acid for 5 minutes then washed out with 5 ml of normal saline prior to filling the post space with packable composite. **Group 4** (experimental): The post space was flooded with 17% EDTA for 10 minutes then washed out with 5 ml of normal saline prior to filling the post space with packable composite. **Group 5** (experimental): The post space was flooded with 10% citric acid for 10 minutes then washed out with 5 ml of normal saline prior to filling the post space with packable composite. All decalcification procedures were carried out on the same day at the same room temperature (20°C ± 2), because an increase in temperature accelerates the demineralizing process\(^5\). Then the composite filled roots were stored in water at (21°C ± 2) for 24 hours after which the teeth subjected to 100 thermocyclings. Each cycle consisted of a 5 minute bath at 37°C, and 5 second bath at 5°C, a 5 minute bath at 37°C, and 5 second bath at 55°C.

For microleakage evaluation the composite filled roots were coated with 2 layers of nail varnish except the coronal surface. The composite filled roots were stored in 1% methylene blue for 24 hours. After immersion in the methylene blue, the composite filled roots were rinsed under running water and sectioned longitudinally using straight slow speed hand piece, separating diamond discs, and water cooling. The sectioned teeth were examined under X20 magnification by stereomicroscope and dye penetration was recorded in mm. Coronal leakage was measured independently by two examiners one of them was unaware of the groups and the average of the two measurements of each tooth was considered for statistical analysis\(^7\). The data were collected and analyzed using One Way ANOVA, and Least significant difference test.

**RESULTS**

Results of this study can be seen in Table.1 and Figure 1.

The mean microleakage values of all groups are presented in Figure 1. It is clear from this bar chart that group5 in which packable composite used in post space after application of 10% citric acid for 10min. showed lowest mean microleakage value (0.2625mm), followed by group4 in which packable composite used in post space after application of 17% EDTA for 10min.
(0.2875mm), followed by group 3 in which packable composite used in post space after application of 10% citric acid for 5min. (0.375mm), followed by group 2 in which packable composite used in post space after application of 17% EDTA for 5min. (0.475mm), followed by group 1 in which packable composite used in post space without previous application of any chelating agent and showed the higher mean microleakage value (0.8125mm). Results expressed statistically highly significant decrease (P<0.0001) in microleakage in all experimental groups in comparison with control group. On the other hand the microleakage of packable composite showed highly significant decrease (P<0.0001) in groups 4, and 5 when compared with group 2. Although group 5 showed least microleakage followed by group 4, and group 3 respectively, but there was no statistical significant difference (P>0.05) between these three groups.

Table 1: Mean, standard deviation (SD), minimum, and maximum microleakage values in mm for all groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean</th>
<th>SD ±</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>0.8125</td>
<td>0.09910</td>
<td>0.7</td>
<td>1</td>
</tr>
<tr>
<td>Group 2</td>
<td>0.4750</td>
<td>0.07071</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Group 3</td>
<td>0.3750</td>
<td>0.08864</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Group 4</td>
<td>0.2875</td>
<td>0.06409</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Group 5</td>
<td>0.2625</td>
<td>0.09161</td>
<td>0.2</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Figure 1: bar chart showing means microleakage values for all groups.

DISCUSSION

Endodontically treated teeth are not strengthened by the placement of the posts, but retention of the restoration is enhanced by the use of the post (2). This study attempted to evaluate the microleakage of packable composite used in post space by using two different chelating agents and two different chelating periods for each chelator.

The mean microleakage value for the control group in present study (0.8125) was consistent with the mean microleakage value found in other study in which they used incremental packing technique for packable composite resin condensed in post space. This study was conducted by Guliz Gorgul et al. in 2003 (3), he studied the mean microleakage value of packable composite used in post space and condensed with two different condensation techniques and it was (0.8225) for control group. So the control of the present study has an accepted mean microleakage value. Also it can be seen that there is no difference in microleakage between the incremental condensation technique and bulk condensation technique. The major elements which contributed to decrease microleakage are bond strength, increased mechanical retention, and tubular resin tag promotion. When tag bond well to the tubule wall, this means resin infiltration into demineralized tubular dentine and lateral branches of the tubules has been occurred (8). It has been speculated that by removing the smear layer and permitting direct contact of the acid etch and adhesive agent with dentine, stronger and more homogenous hybrid layer would be created and preventing the formation of a defective zone at the base of the hybrid layer (9). The present study showed that the dentine substrates which have been exposed to chelating agents exhibit reduction in microleakage that was statistically highly significant when compared to control group. The results may be explained as after smear layer demineralization by using a chelating agent, the tubules orifices are enlarged because of dissolution of peritubular dentine (10). This may be resulted in a network for adhesive resin tag formation within the dentinal tubules and the anastomosing of lateral canals, which may be fundamental to the development of a stronger dentine resin bond (11) and hence a reduction in microleakage value. Also it was found, that citric acid showed more reduction in the mean microleakage values than EDTA did, but there was no statistical difference between them when the same working time of chelation was used. This may be attributed to the chelation energy of EDTA which is more pronounced than its deminerlizing activity when compared to citric acid (5). Although a different type of adhesive system was used (total-etch, fifth generation), but still these results are in agreement with the results of Jacques & Hebling in 2005 (10). They found that the application of the adhesive system (selfetching primer, fifth generation) following the
application of a chelating agent produced statistically higher bond strength.

In this study the reduction in microleakage values with increasing the working time of chelators on dentine substrates may be attributed to the increase in EDTA and citric acid activity to deminerlize the smear layer and even dentine erosion with increasing time of application (10). This may be resulted in more adhesive resin infiltration and hence well adapted and deeper resin tags were formed, which in turn reduced the microleakage.

Nevertheless, at present, no definite recommendation can be given on the optimal amount and working time for a paste or liquid chelator under clinical conditions (10).

REFERENCES


3. Guliz Gorgul; Tayfun Alacam et al. Microleakage of packable composites used in post spaces condensed using different methods J Contemp Dent Pract 2002; May: 3(2).


