Evaluation of abrasion of Glass Ionomer Cement, Nano filled composite resin, Hybrid composite resin and highly filled composite resin against removable partial denture clasp

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Abstract
Objectives: To quantitatively assess and compare abrasive resistance in four different types of restorative materials on the abutment tooth against cobalt-chromium clasp of the cast partial denture. Material and methods: Twenty extracted posterior teeth were collected. Class V cavity was prepared on all the teeth. They were randomly divided into four groups. Group 1 was restored with Glass Ionomer Cement (Fuji-2™), Group 2 with hybrid composite (Filtek-z100™), Group 3 with Nano filled composite (Esthet-X™) and Group 4 with highly filled composite (Surefil™). The restoration was abraded using cobalt-chromium rod which acted like the clasp of a removable partial denture during abrasion testing. Results: Abrasion was significantly more pronounced in group 1 with a mean of 201mg loss while group 4 showed least amount of wear with a mean loss of 108mg. Group 4 differed significantly in comparison to Group 1, Group 2 and Group 3 at 1% level of significance. Conclusions: Glass Ionomer cement was least durable (low abrasive resistance) when used as a restorative material under partial denture clasp. Highly filled composite had better abrasive resistance in comparison to other composite restorative resins used in the study.

Key words: Abrasion; Removable Partial Denture Clasp; Composite Resin; Glass Ionomer Cement.
Introduction

One of the most important steps in the construction of the removable partial denture is designing and placement of its components. Retention of the removable partial denture is accomplished by direct retainers. Commonly direct retention is achieved by placing clasps into undercuts on the abutment teeth. Friction between the clasp and the tooth structure is mainly responsible for the retention of the prosthesis. During placement and removal or during function the clasp can eventually lead to the abrasion of restoration. In certain situations the natural undercut areas may have a class V restoration due to cervical caries, abrasion or creation of an artificial undercut area may be required for proper placement of clasp (1, 2), and such a situation may require re-contouring by restorative procedure. Therefore abrasive resistance of the restorative material against clasp plays a vital role in maintaining the relation between the retentive terminal of the clasp and the restored abutment tooth.

The aim of the study was to quantitatively assess and compare abrasive resistance in four different type of restorative material on the abutment tooth by cobalt-chromium clasp of the cast partial denture.

Material and methods

This was an in-vitro study. The restorative materials used to evaluate the abrasion caused by cobalt-chromium clasp were Type-II Glass Ionomer cement, Nano filled composite, Hybrid composite and Highly filled composite. Brands of restorative materials used were Fuji-2™, Esthet-X™, Filtek-z100™ and Surefil™ respectively. Twenty Extracted posterior teeth were collected which included both maxillary and mandibular teeth to mimic the restored abutment surface.

The extracted teeth were first disinfected using Sodium Hypochlorite solution. Using a Ney’s dental surveyor, the height of contour of the teeth was marked, and then the teeth were mounted horizontally on an acrylic block (Figure 1).

Class V cavity of 2mm depth and 3mm width was prepared cervical to the height of contour on all the samples. The depth was standardized with the help of the rubber stopper attached to the shank of the inverted cone bur. The width was standardized with the help of a template of 3mm which was used to mark the outline of the cavity. Then the specimens were randomly divided into four groups with five samples in each group. Group 1 was restored with Glass Ionomer Cement (Fuji-2™), Group 2 with Hybrid composite (Filtrek-z100™), Group 3 with Nano filled composite (Esthet-X™) and Group 4 with highly filled composite (Surefil™) following the manufactures instructions. A dimpled plastic matrix band of 1mm depth was used to create uniform artificial undercut over the buccal surface of all the samples. The samples were then marked accordingly for identification. A cobalt-chromium rod of length 5cm and diameter of 2mm was casted to mimic a clasp. The cobalt-chromium rod was mounted on an acrylic block after finishing and polishing. The specimens from the entire four groups were individually weighed in a digital weighing scale and values were recorded and tabulated.

Figure 1: Horizontally mounted natural teeth on acrylic blocks
An electric fatigue testing instrument was modified and used to move the restored surface of the specimen over the cobalt-chromium rod (Figure 2). Cobalt-chromium rod was attached to the upper jig and the specimens were attached to the lower jig (Figure 3). A load of 1Kg was applied perpendicular to the restored surface of the specimens during abrasion (3). Based on the assumption that the patient removes and inserts the prosthesis four times a day, test was carried for 7300 cycles, which equals 5 years of clinical usage. To simulate the oral condition the abrasion was carried out in constant supply of normal saline. Micro movement of the prosthesis during function was not considered.

After completion of the test the specimens from each group were individually weighed in a digital weighing scale (Fig. 4) and values were recorded and tabulated. The difference in the weight between pre and post test gave the amount of abrasion of the restorative materials in milligrams. The raw data was collected and statically analyzed by One Way ANOVA and Turkey’s honest significant difference test for pair wise comparison.

**Results**

Table 1 shows the mean and standard deviations of the amount of loss of restorative material. Abrasion was significantly more pronounced in group 1 with a mean of 201mg loss while group 4 showed least amount of wear with a mean loss of 108mg. Group 2 and group 3 showed a mean wear of 173mg and 154mg respectively. There was a significant difference between the groups for abrasion.

Table 2 demonstrates pair wise comparison by Turkey’s honest significant difference test. Group 4 differed significantly in comparison to Group 1, Group 2 and Group 3 at 1% level of significance. This indicates that tooth surface re-contoured using highly filled composite (group 4) have superior resistance to abrasion by removable
Abrasion of restorative materials against partial denture clasp

denture clasp during repeated cycles of placement and removal.

Table 1: Mean, standard deviation and coefficient of variation (CV) for the amount of loss of restorative material after abrasion

<table>
<thead>
<tr>
<th>Groups</th>
<th>Means</th>
<th>Standard Deviation</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>201.200</td>
<td>14.0961</td>
<td>7.0060</td>
</tr>
<tr>
<td>2</td>
<td>173.800</td>
<td>4.0866</td>
<td>2.3513</td>
</tr>
<tr>
<td>3</td>
<td>154.400</td>
<td>5.6391</td>
<td>3.6523</td>
</tr>
<tr>
<td>4</td>
<td>108.000</td>
<td>6.5192</td>
<td>6.0363</td>
</tr>
</tbody>
</table>

One way ANOVA, P<0.001

Table 2: Pair wise comparison between the groups

<table>
<thead>
<tr>
<th>Mean</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>P value</td>
<td>2</td>
<td>0.0007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P value</td>
<td>3</td>
<td>0.0002</td>
<td>0.0116</td>
<td></td>
</tr>
<tr>
<td>P value</td>
<td>4</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.0002</td>
</tr>
</tbody>
</table>

Turkey's honest multiple comparison test

Discussion

The aim of the study was to evaluate the wear resistance of three types of composite and Glass Ionomer cement by removable denture clasp on repeated movement on the restored surface. These materials were chosen as they are commonly used materials to restore any cervical defects or to form artificial undercuts on natural abutment teeth (1, 2). There were no previous studies undertaken to quantitatively compare the wear of different type of composite resin and Glass Ionomer cement by removable denture clasp. Bates (3) suggested that, as a clasp moves over an undercut, applies a load of 1kg on the abutment tooth. Therefore a load of 1kg was applied on to the test samples during testing.

It was observed that abrasive resistance are in decreasing order as Group 4> Group 3> Group 2> Group 1. Group 1 showed the maximum amount of abrasion, the samples of which were re-contoured using Glass Ionomer cement. This can be attributed to inferior physical and mechanical property of the cement in comparison to composite resins (4).

Highly filled composite (Group 4) had the maximum resistance to wear when compared to other three groups.

The results of the present study is in accordance with the study done by Clelland et al., (5) who suggested the use of highly filled micro hybrid composite in areas of high stress to reduce wear. The present study also indicates that highly filled composite resins have better abrasive resistance when compared to the restorative materials used in other groups, within the limitations of the study, i.e., the in vitro design could not mimic the abrasion caused by the clasp during function and limited sample size.

Conclusions

From the present study it can be concluded that Glass Ionomer cements are least durable when used as a restorative material under partial denture clasp and highly filled composite resins are clinically durable than other composite resins.

References