The influence of posterior composite type and application technique on the fracture resistance of maxillary premolar teeth (an in vitro study)

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ABSTRACT

Background: A restorative material with the potential to increase resistance to cuspal fracture is available to dentists and the packable composite is one of them. This in vitro study was conducted to evaluate and compare the cuspal fracture resistance of weakened maxillary premolar teeth with MOD preparations restored with different composite materials and techniques.

Materials and Methods: Fifty maxillary premolar teeth were divided into five groups (n=10). Class II MOD cavities were prepared in forty specimens. Group A, were sound. Group B were prepared but not restored. Group C and D were restored with successive cusp build up using Z250 microhybrid for group C and P60 packable for group D. Finally, Group E was restored with bulk using P60 packable. A 5 mm diameter steel sphere contacted the buccal and lingual cusps of the tested teeth until fracture occurred. The values obtained in this study were subjected to Analysis of Variance (ANOVA) and student t – test was carried out between the two types of posterior composite materials.

Results: There’s a high significant improvement of the fracture resistance of restored teeth using posterior composite as compared to the unrestored ones, but; there’s no difference of the type of the posterior composite material used, or the type of placement technique used, while the sound teeth remained the strongest teeth compared with all the other groups.

Conclusions: The study concluded that Posterior composite resin restoration whatever type or technique used, showed a great improvement in the resistance to cuspal fracture.

Keywords: composite resin, successive cusp build up, fracture resistance.

INTRODUCTION

Attention has focused on the strength of teeth after preparation for restorative treatment as it relates directly to their long – term longevity in the oral environment. Actually the use of adhesive materials to reinforce weakened teeth and support undermined enamel has been widely supported and many studies have shown that the weakening effect of cavity preparation can be alleviated with the use of such materials; the fracture resistance of teeth restored with adhesive materials is increased by 80 – 362% (1). Packable composites are promoted for stress – bearing posterior restorations with improved handling properties and possible bulk curing of the restorations are some of the advantages (2).

One way to reduce the effect of contraction stress is the incremental layering of resin – based composites during placement to minimize bridging between cavity walls and to reduce shrinkage stresses through the sequential use of small volumes of material, But, the benefit of the incremental technique for reducing polymerization contraction stresses is somewhat controversial (3).

The aim of this study was to evaluate and compare the cuspal fracture resistance of weakened maxillary premolar teeth with MOD preparations restored with different posterior composite materials and techniques.

MATERIALS AND METHODS

Fifty maxillary premolar teeth removed for orthodontic purposes were collected immediately after extraction and placed in distilled water at room temperature before being evaluated for use in this study. All of the teeth selected were intact, noncarious, and unrestored. They were cleaned with pumice and examined under a magnifying lens to detect any pre-existing defects.

To simulate the periodontium, root surfaces were dipped into melted sticky wax to a depth of 2 mm below the facial CEJ junction to produce a 0.2 to 0.3 mm layer approximately equal to the average thickness of the periodontal ligament. Teeth were then mounted in cold cure acrylic resin confined in a casting metal ring. Each tooth was then reinserted into the test block, and the polyether material was allowed to set. Excess polyether material was removed to provide a flat surface 2 mm below the
facial CEJ of each tooth. The thin layer of polyether material simulated the periodontal ligament (4, 5). Care was taken to prevent dehydration of the specimens. They were then stored in distilled water.

The distance from the buccal cusp tip to the CEJ and the intercuspal distance on the occlusal surface of each tooth were measured using a vernier to standardize the cavity preparations. Class II MOD cavities were prepared in all specimens with parallel walls and no proximal boxes, except group A. The resulting isthmus width was 1/3 the intercuspal distance and 5mm from tip of facial cusp depth of the cavity. After preparation, the teeth were randomly divided into five groups (n=10). The teeth in group A were sound not prepared. Teeth in group B were prepared not restored. With exception of the composite type and placement technique, specimens in group C, D, and E were restored using the Adper Single Bond2 adhesive system and Z250 composite resin for group C and P60 composite resin for group D and E (3M dental product-ESPE, USA) following the manufacturer’s recommendations. Ivory no.8 retainer and a metal matrix band were placed on each specimen. Specimens in group C and D were restored with successive cusp build up (Figure 1), in this technique, the first composite increment is applied to a single dentin surface without contacting the opposing cavity walls and the restoration is build up by placing a series of wedge – shaped 1.5-mm, triangular apicobuccal layers of uncured composite that are condensed and sculpted directly in the preparation using a composite instrument. Specimens in group E were restored in bulk technique (Figure 2) using P60 packable, and Z350 flowable as initial layer. The specimens were stored for one week in distilled water in 100% relative humidity at 37°C, and the fracture test was conducted in an compressive testing machine, using the compressive testing machine, using the stereomicroscope; are observed in the Table (3) for the fractured restored groups C, D, and E.

**RESULTS**

Data obtained by the fracture test for each of the studied treatments were submitted to ANOVA for a totally random design. The estimated F value was 17.83, showing a statistical significant difference (P < 0.01) among five estimations of means value (Table 1 and Figure 3). Student t – test was used to show comparison between the means of forces using one type of adhesive bonding agent (Adper Single Bond2) with two types of restorative composite materials, Z250 microhybrid and P60 packable (considering group D and group E as one group). The results are presented in Table (2) which showed that there was a non significant difference (t = 0.30 P > 0.05). The ANOVA test revealed that between group A (sound teeth) and group B (unrestored) there was a highly significant difference (P < 0.01). Among group A and groups: C (Z250 / incremental), D (P60 / incremental), E (P60 / bulk), there was a significant differences (P < 0.05). Moreover; among group B and groups: C, D, E, there was a highly significant differences (P <0.01). On the other hand, between group C and group D, between group C and group E, between group D and group E there was a non significant difference (P > 0.05). The mode of failure observed after testing the specimens in compressive testing machine, using the stereomicroscope; are observed in the Table (3) for the fractured restored groups C, D, and E.

**DISCUSSION**

The restorative material is not only restoring the lost tooth structure, but also to strengthen the tooth and provide an effective seal between the restoration and the tooth. Comparing the results of fracture resistance to cusps statistically of this study revealed that the force required to fracture the cusps of group B (unrestored) (force mean=79.03Kgf) represents the lowest value among the five groups, while the restorative groups C (force mean=158.6Kgf), D (force mean=158.1Kgf) and E (force mean=167.7Kgf); their improvement in fracture resistance was statistically high significant. This result concluded that tooth reinforcement is another benefit of posterior bonded composite resin restorations. This high significant differences in fracture resistance between the unrestored and restored groups may be due to that the micro-mechanical bonding between bonding system and tooth structure tend to bind the walls of the cusps together and strengthen the remaining tooth structure and to distribute the forces more evenly among the various interfaces in composite restorative material that have been bonded to enamel and dentin by adhesive bonding agent. This reduction in localized forces offer greater opportunity for reinforcing tooth structure and increases the fracture resistance of the cusps. This result was in an agreement with (5, 7). The present study the statistical analysis of differences among group D (P60 packable / incremental) and group E.
(P60 packable / bulk) was statistically non-significant, despite that there’s an improvement in the fracture resistance force mean for group E (P60 / Bulk), in contrast to that of group D (P60 / incremental), even such improvement was not significant. Which revealed that the mode of application technique employed of the packable composite has no difference on the cuspal reinforcement of the weakened teeth to a cavity depth of 5mm? The presence of white lines between successive layers of resin composite or inside layers is an indication for improper adaptation of the layers with each other, which also affects physical properties. In Bulk build up a whole single increment was adapted properly to the floor and cavity walls, which eliminates the possible previous defects correlated to the composite successive increments. This explanation could be more accepted for the packable composite\(^{10,11}\). In our study it’s seemed that Z250 and P60 are sharing many of their physical properties and have closure values for each other including the modulus of elasticity\(^{12}\). Also using of the same bonding system, these factors for both posterior composite types are approximate from each other which may explain the comparable values of both materials of the cuspal deflection and therefore on the cuspal fracture resistance. The majority of cohesive failure for group D supported the explanation; that successive incremental technique with packable composite resulted in weakening of the flexural strength of the material itself and reduced the surface hardness as a result of dry spots and voids in between the resin layers coming from the improper adaptation of the heavy filled material.

Table 1: Descriptive statistics of values of five groups.

<table>
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<tr>
<th></th>
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<th>GB</th>
<th>GC</th>
<th>GD</th>
<th>GE</th>
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<tr>
<td>Mean</td>
<td>204.5</td>
<td>79.03</td>
<td>158.6</td>
<td>158.1</td>
<td>167.7</td>
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<tr>
<td>S.D</td>
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<td>35.51</td>
<td>42.48</td>
<td>27.82</td>
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<tr>
<td>S.E</td>
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<td>11.23</td>
<td>13.44</td>
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<tr>
<td>C.V%</td>
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<td>44.93</td>
<td>26.79</td>
<td>17.6</td>
<td>13.63</td>
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</tbody>
</table>

Table 2: Mode of failure observed in the fractured restored specimens of groups C, D, and E.

<table>
<thead>
<tr>
<th>Groups</th>
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<th>Adhesive</th>
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<tbody>
<tr>
<td>Group C</td>
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<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Group D</td>
<td>7</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Group E</td>
<td>1</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

Figure 1: Successive cusp builds up technique; A group C using microhybrid Z250 composite, B group D using packable P60 composite with flowable composite

Figure 2: Bulk technique using P60 packable composite with flowable one

Figure 3: Means of fracture forces values in (Kg f) for the five groups
REFERENCES


11. 3M Dental products; Filtek P60 technical manual. Minneapolis: 1999; 5–33.