Fracture resistance of premolars with extensive cavity preparation restored with different bulk fill composite materials (A comparative in vitro study)

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ABSTRACT

Background: Restoration of posterior teeth with extensive carious lesions is one of the biggest challenges in dentistry. Several studies have directed to measure the fracture resistance of teeth restored with various types of materials. However, few data is available about the influence of different bulk fill composite materials while restoring an extensive cavity size.

Objectives: The aim of this study was to evaluate and compare the ability of contemporary bulk fill composite materials to restore the strength of premolars with extensive MOD cavity preparation.

Material and methods: Sixty sound, human maxillary premolars extracted for orthodontic purposes were selected and divided into five groups (n=12). Standardized extensive class II MOD cavities were prepared for the teeth in groups A, B, C and D and then restored with four types of posterior composites; Group A with Filtek™ One bulk, Group B with Tetric Evoceram, Group C with Beautifil, and Group D with Alert condensable composite. Group E was unrestored and saved as control. The fracture resistance was recorded for all the teeth using an Instron testing machine by subjecting them to a compressive loading until fracture. Mode of failure was evaluated. Data was analyzed statistically using "one-way ANOVA and LSD tests" at 0.05 level of significance.

Results: The results showed a statistically significant difference among all groups (P = 0.000). Significant decrease in fracture resistance values was recorded for group (A) compared with the other restored groups (P =0.000) with no significant differences between the other three groups. A higher percentage of mixed modes of failure was recorded for all the restored groups with no significant differences.

Conclusions: All the restored premolars with extensive MOD preparations were compromised compared with the sound teeth. Filtek™ One bulk nanofill composite produced the least fracture resistance compared with the other restored and sound teeth.

Key words: Fracture resistance, bulk-fill, extensive MOD preparations

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INTRODUCTION

The removal of dental structure due to operative procedures has a direct relation with a decrease in fracture resistance of the teeth [1].Strength of the tooth decreases proportionally as the amount of dental tissue is removed, and when a considerable amount of the dental structure is lost, this lead to increase in weakness and susceptibility to

fracture especially in relation to the bucco–palatal width of the occlusal box preparation. Smaller teeth with large "MOD cavities" are strictly weakened due to loss of the reinforcing structures "such as the marginal ridge". hence becoming more prone to fracture [2]. The advancement of composite materials and adhesive techniques has significantly changed the way to restore teeth in the posterior region. Preferences of adhesive restorations are not only for the aesthetic nature, but also related to the possibilities of preserving a larger amount of healthy tissue and strengthening the residual dental structure [2, 3]. Operative dentistry is usually combining the removal of a carious tissue during cavity preparation while compensating the deficient properties by the restorative materials. However, the application of a load on the teeth with large restorations creates a wedge effect between the buccal and palatal cusps, leading to the reduction of fracture resistance and a higher incidence of catastrophic fracture [2]. Several researches reported that restoring large preparations with adhesive materials, complete or partial recovery of fracture resistance can be restored [4, 5].

Placement the composites resin in large cavities has been addressed as an effective issue and several techniques have been adopted. Some researchers showed that incremental layering technique is recommended due to its ability to minimize the consequences of shrinkage stress, and allow an adequate degree of conversion of resin matrix [6]. However, it has a number of drawbacks such as; incorporation of voids, difficulty in placement of increments into small cavities, increased of operational time, and interlayer contamination [7]. Bulk fill composites, on the other hand, have been advocated to be capable of minimizing the time and effort required for layering technique when placing composite resin in posterior teeth. It eliminates the possibility of voids incorporation between the layers, enabling up to 4 mm increments to be cured in a single step without adversely affecting polymerization shrinkage kinetics and macromechanical properties [8]. Restorations with bulk-fill composites can decrease the cuspal deformation and shrinkage stress that would cause the fracture resistance to improve [9].

Several studies have focused on the fracture resistance of teeth with different restorative materials. However, most of these studies neglect the cavity size as an influencing variable [3, 7]. Although there were preceding studies that used the compression test, this study evaluated new materials that have not yet been evaluated concerning this property for premolars with a large Class II MOD. Therefore, this study was conducted to evaluate the ability of using four different contemporary restorative composite materials using bulk fill technique to restore the strength of premolars with extensive MOD cavity preparations.

OBJECTIVES

This in vitro study aimed to evaluate and compare the fracture resistance of maxillary premolars with extensive MOD cavity preparations restored with four different composite materials which were; nanofill composite (Filtek™ One bulk fill), nanohybrid composite (Tetric EvoCeram® bulk fill), bulk-fill giomer (Beautifil® Bulk Restorative), fiber–reinforced composite (Alert Condensable Composite), and evaluate the mode of fracture for the restored groups. The null hypotheses of this study were: 1) there is no difference in the fracture resistance of sound and restored groups and 2) no difference in the mode of fracture among the restored groups regardless of the restorative composite material that is used.

MATERIAL AND METHODS

Sixty sound, non-carious human maxillary first premolars that were extracted for orthodontic treatment were collected for this study. Any calculus deposits and soft tissue were carefully removed. All the teeth that were used in this study had regular occlusal anatomy with completely formed apices and absence of cracks, restorations, or caries.
lesions. The teeth that showed any defects were excluded from this study. The teeth that were selected had a bucco-palatal width varied between (8.9 - 9.7 mm), and miso-distal width varied between (6.9 - 7.6 mm). After cleaning, the teeth were soaked in a 0.1% thymol solution for 48 hours.

All the teeth were embedded, in a fabricated silicon mold with dimension of (20 mm × 20 mm × 25 mm) that filled with self-cure acrylic resin (at dough stage) (Duracryl™ Plus, Czech Republic). The teeth were positioned along their long axis using a dental surveyor (Dentaurum, Germany) to the level of 2 mm beyond the CEJ (to simulate the alveolar bone). A rubber dam liquid (FGM, Brazil) was used to fix each tooth to the vertical arm of the surveyor before pushing it in the acrylic. In order to simulate a periodontal ligament of the teeth, a wax layer was applied around all the teeth. The root surfaces were immersed into a molten wax up to 2.0 mm apical to the cemento-enamel junction. Then the wax layer was substituted by a silicone light body impression material in order to simulate the periodontal ligament.

Then the teeth were divided randomly into five groups of twelve tooth each (n=12) according to the type of the restorative material used: Group A using a nanofill composite (Filtek™ One bulk fill posterior restoration, 3M ESPE, USA), Group B using a nanohybrid composite (Tetric EvoCeram bulkFill, Ivoclar Vivadent, Liechtenstein), Group C using bulk-fill giomer (Beautifil-bulk, SHOFU, Japan), Group D using a fiber-reinforced composite (Alert condensable composite, Pentron, USA), and Group E the teeth were left intact to serve as control. The inter-cuspal distances of the teeth of each group were measured. Statistical analysis using one way ANOVA test was performed among the groups for the intercuspal measurements among the five groups. The restoration materials that were used in this study with their manufacturing details are listed in (Table 1).

Table 1. The composite resins used and their composition.

<table>
<thead>
<tr>
<th>Composite</th>
<th>Type of Composite</th>
<th>Manufacturer</th>
<th>Resin components</th>
<th>Filler type and size</th>
<th>Weight</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filtek One Bulk Fill</td>
<td>Nano-filled</td>
<td>3M ESPE, St. Paul, USA</td>
<td>UDMA, AUDMA, DDMA, proprietary AFM</td>
<td>a combination of a non-agglomerated/non-aggregated 20 nm silica filler, a non-agglomerated/non-aggregated 4 - 11 nm zirconia filler, the agglomerated ytterbium trifluoride (YbF3) is 100 nm in size.</td>
<td>76.5 %</td>
<td>58.5%</td>
</tr>
<tr>
<td>EvoCeram® Bulk Fill</td>
<td>Nano-hybrid</td>
<td>Ivoclar Vivadent, Liechtenstein.</td>
<td>Bis-GMA, Bis-EMA, UDMA</td>
<td>Barium-alumo-silica, spherical mixed oxide, prepolymer filler. Particle sizes (40 nm -3</td>
<td>80%</td>
<td>61%</td>
</tr>
</tbody>
</table>
Before any cavity preparation for the experimental teeth was performed, a flowable composite resin (Harvard, Germany) was used to take an impression for the occlusal surfaces of the teeth in order to produce a stamp mold. After the flowable composite resin was applied on the occlusal surface of each tooth, a disposable bond brush (Lingchen, China) was immersed into the composite and polymerized by a light cure unit to act as a handle to facilitate the removal and application of the stamp.

A large class II MOD cavity preparation was prepared by using a parallel-sided, flat-ended diamond fissure bur of 1.2 mm diameter (Komet, Germany) in a high-speed turbine hand piece (NSK, Japan) with water cooling. Before cavity preparation of the teeth, the outline of the cavity was drawn with a permanent color marker. To standardize the cavity preparation, the preparation was carried out by the same operator with the use of a modified dental surveyor. The dimensions of the cavities were standardized as follows; the occlusal box that is 2 mm deep (in relation to the bottom of the groove), the occlusal box width buccolingually was 2/3 of the intercuspal distance to produce an extensive cavity preparation (two reference points were made with a water proof color marker on the tips of the buccal and palatal cusps). The MO and DO boxes were prepared with a 2 mm width at the gingival seat and 1.5 mm height at their axial walls (Fig. 1). The facial and lingual walls of the cavity were prepared parallel to each other with the cavo-surface margins were prepared at 90°, and rounded internal line angle by using a small round bur (Komet, Germany).
After complete cavity preparation, the cavity was rinsed with deionized water and dried using gentle air blast. In all groups, excepting group E which served as a control group, "Single Bond Universal Adhesive" (3M ESPE, USA) with selective etch technique was used for standardization. The enamel margins of the cavity was conditioned with a 37% phosphoric acid gel (super etching, SDI, Australia) for 15 seconds, rinsed thoroughly with water for 30 seconds to ensure removal of the etching material, and then exposed to a gentle stream of air for 2 seconds at a distance of nearly 1 cm. After that, "a single bond universal adhesive" was applied with a disposable bond brush to the whole cavity (both enamel and dentin) and rubbed on the cavity for 20 seconds, followed by a gentle air thinning for 5 seconds. The adhesive was then light cured with an LED light cure device (radii plus, SDI, Australia) with a power intensity of 2100 mW/cm² for 10 seconds according to the manufacturer's instructions. The intensity of the light was checked by using a radiometer (SDI, Australia) prior to each curing procedure to ensure standardization.

Before application of the restorative material, a matrix band was applied around each tooth. SuperMat® Adapt® SuperCap® Matrix system (Kerr Hawe SA, Switzerland) was used as a band adopter and was changed after each restoration.

The four bulk fill composite materials, namely, Filtek™ One Bulk Fill, Tetric Evo Ceram® Bulk Fill, Beautifil-Bulk, and Alert condensable composite were applied into the prepared cavity in a single layer according to the manufacture instruction. Using CompoRoller™ instrument (Kerr Hawe SA, Switzerland) the resin was compacted and adapted to ensure that there were no gaps between the material and the tooth. A teflon tape was adapted on the occlusal surface and the stamp of each tooth was placed and pressed to simulate the same occlusal shape of the original tooth anatomy without over or under filling. Next, the stamp was displaced and the excess material was removed by using CompoRoller™ instrument. Then the composite material was cured from the occlusal direction for 20 seconds. The tip of LED curing unit touched the cusp tips during curing. After the removal of the matrix, a further light curing time from buccal and lingual sides was applied for 20 seconds each to ensure uniform exposure of all surfaces. Minimal finishing and polishing was made by using a perfect polish one step diamond polishers kit (Itena, United States). After finishing of the restoration, the specimens were stored in an incubator at 37°C and 100% humidity for 24 hours. The specimens were thermocycled by using an automatic thermocycling device for 500 cycles between 5°C (± 2°C) to 55°C (± 2°C) using a dwell time of 30s.

To measure the fracture resistance, all the specimens were exposed to a compressive axial loading until fracture in a universal testing machine (Computer controlled universal testing machine, Laryee Technology, China). The active tip with a metal sphere (8 mm in diameter) was positioned at the center of the occlusal surface of each tooth, touching only the tooth structure (at the slopes of the cusps). The vertical loading of the testing machine was applied at a speed of 0.5 mm/min until specimens’ fracture. The force at the moment of specimen fracture was recorded for all the groups in Newton (N).

The fracture pattern of the teeth for the four restored groups were evaluated under a stereomicroscope (Meiji Techno CO. LTD, Japan) at a magnification of 20 X. The type of fracture mode was classified according to the location of the fracture to three modes of failure as follow [10]:

A: "Adhesive mode of failure in which the failure occurs at the tooth restoration interface"
C; "Cohesive mode of failure in which the fracture is inside the bulk of either the tooth or the restorative material” 
M; "Mixed mode of failure in which the failure is both adhesive and cohesive”

The data was statistically analyzed using IBM SPSS Statistics (SPSS for Windows, version 26; IBM Corp). One-way analysis of variance (ANOVA) and Post hoc least significant difference tests were used to analyze the data. The level of significance was assumed at $P \leq 0.05$.

**RESULTS**

The mean, standard deviation “SD”, minimum and maximum values of the fracture resistance for all the groups are shown in (Table 2). “ANOVA test” showed that there was a statistically significant difference among all groups ($P=0.000$). LSD test recorded statistically significantly difference between the groups (Table 3). Significant differences in fracture resistance values were recorded between the control group (Group E) and all of the restored groups ($P=0.000$). Additionally, a statistically significant decrease in fracture resistance values was recorded between the teeth that were restored with Filtek™ one (Group A) and all of the other three restored groups ($P=0.000$). On the other hand, there was a non-significant difference in fracture resistance values when comparing the teeth restored with Tetric Evoceram (Group B), with both those restored with Beautifil (Group C) and Alert (Group D) ($P > 0.05$).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Number</th>
<th>Mean (N)</th>
<th>SD</th>
<th>Minimum (N)</th>
<th>Maximum (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A (Filtek™ One)</td>
<td>12</td>
<td>469.50</td>
<td>87.19</td>
<td>362</td>
<td>600</td>
</tr>
<tr>
<td>Group B (TetricEvoceram)</td>
<td>12</td>
<td>723.16</td>
<td>115.30</td>
<td>500</td>
<td>884</td>
</tr>
<tr>
<td>Group C (Beautifil-Bulk™)</td>
<td>12</td>
<td>777.16</td>
<td>173.71</td>
<td>550</td>
<td>990</td>
</tr>
<tr>
<td>Group D (Alert)</td>
<td>12</td>
<td>784.66</td>
<td>174.01</td>
<td>518</td>
<td>998</td>
</tr>
<tr>
<td>Group E (Sound teeth)</td>
<td>12</td>
<td>1166.75</td>
<td>237.76</td>
<td>838</td>
<td>1599</td>
</tr>
</tbody>
</table>
Table 3. LSD test results between the different groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>(J) factor</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Filtek™ One)</td>
<td>Group B</td>
<td>-253.66 *</td>
<td>67.79</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Group C</td>
<td>-307.66 *</td>
<td>67.79</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Group D</td>
<td>-315.16 *</td>
<td>67.79</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Group E</td>
<td>-697.25 *</td>
<td>67.79</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Tetric Evoceram)</td>
<td>Group C</td>
<td>-54.00</td>
<td>67.79</td>
<td>.429</td>
</tr>
<tr>
<td></td>
<td>Group D</td>
<td>-61.50</td>
<td>67.79</td>
<td>.368</td>
</tr>
<tr>
<td></td>
<td>Group E</td>
<td>-443.58 *</td>
<td>67.79</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Group C</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Beautifil-Bulk™)</td>
<td>Group D</td>
<td>-7.50</td>
<td>67.79</td>
<td>.912</td>
</tr>
<tr>
<td></td>
<td>Group E</td>
<td>-389.58*</td>
<td>67.79</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Group D</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Alert)</td>
<td>Group E</td>
<td>-382.08*</td>
<td>67.79</td>
<td>.000</td>
</tr>
</tbody>
</table>

"The mean difference is significant at P ≤0.05"

Regarding the modes of fracture, the number and percentage of the modes of failure for the four restored groups are presented in (Table 4). Kruskal-Wallis test revealed a statistically non-significant difference among the restored groups (P > 0.05) (Table 5).
Table 4. The distribution of modes of failure for the restored groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Adhesive</th>
<th>Cohesive</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N/12 (%)</td>
<td>Within tooth structure N/12 (%)</td>
<td>Within restoration N/12 (%)</td>
</tr>
<tr>
<td>Group A (Filtek™ One)</td>
<td>2/12 (16.7%)</td>
<td>5/12 (41.7%)</td>
<td>-</td>
</tr>
<tr>
<td>Group B (TetricEvoceram)</td>
<td>2/12 (16.7%)</td>
<td>3/12 (25%)</td>
<td>-</td>
</tr>
<tr>
<td>Group C (Beautifil-Bulk)</td>
<td>1/12 (8.3%)</td>
<td>4/12 (33.3%)</td>
<td>1/12 (8.3%)</td>
</tr>
<tr>
<td>Group D (Alert)</td>
<td>1/12 (8.3%)</td>
<td>3/12 (25%)</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 5. Kruskal Wallis Test.

<table>
<thead>
<tr>
<th>Kruskal-Wallis H</th>
<th>df</th>
<th>Asymp. Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.477</td>
<td>3</td>
<td>.688</td>
</tr>
</tbody>
</table>

**DISCUSSION**

Restoring premolars with C1I cavities using composite resin materials is becoming necessary for aesthetic reasons. However, it is essential to restore function as well, by using a material with high mechanical and chemical properties. "Maxillary first premolars" were selected for this study because their position requires the use of tooth colored restorative materials for aesthetic reasons. In addition to that, the occlusal anatomy and cuspal inclination make them more susceptible to fracture under occlusal load. Furthermore, these teeth can be easily fractured when treated with cavity preparation, mostly when the marginal ridge is thin or completely removed [11].

In this study, the highest mean value of fracture resistance was presented by the intact teeth (Group E), with a significant difference compared with the other four restored groups (P < 0.05). Therefore, the first null hypothesis of this study was rejected. This can be contributed to the presence of intact palatal and buccal cusps with intact mesial and distal marginal ridges, which form a continuous circle of the tooth structure that reinforces and preserves the integrity of any sound tooth. This result is in agreement with many other studies compared the fracture resistance of sound teeth and teeth restored with different composite restorations [12, 13].

Among the restored groups of this study, the group that was restored with Filtek™ One (Group A) showed the lowest fracture resistance mean value (469.50 N) with statistically significant difference as compared with the other
three groups (P < 0.05). This result could be attributed to the differences in the filler loading of the composite resin and to the type of fillers within a resin.

Previous studies have established a positive correlation between the filler loading and the mechanical performance of a material. High values of mechanical parameters appear to be as a result of high level of filler loading [14]. High filler loading increases the physical and mechanical properties such as; flexural strength, flexural modulus, fracture toughness, and hardness of the composite resins [9, 15]. From a mechanical point of view, the mechanical parameters of a material have an important effect on its fracture resistance. This could be best explained when an object is examined in compression stress. Failure due to compression stress might occur as a consequence of complex stresses that are produced within an object. During compression, forces are resolved into tensile and shear forces [16]. It is of importance that a material that is proposed for use as a posterior restoration must have high compressive and flexural strengths to interpret these stresses and provide persistent resistance against a heavy load without fracturing. On the other hand, the increase in the applied load will extent to a point upon which the material will either undergo sudden fracture (catastrophic failure), or will undergo plastic deformation which depends on its stiffness or rigidity, signified by its flexural modulus. A high modulus means the material is rigid and does not distort significantly under occlusal load [17].

Besides, higher filler content of a resin material tended to enhance the fracture resistance for the teeth [18]. In this study Filtek™ One composite which contains the lowest percentage of fillers loading (76.5% wt, 58.5% vol), in comparison to Beautifil, Tetric EvoCeram® and Alert (87% wt, 74.5% vol; 80% wt, 61% vol; and 84% wt, 70% vol, respectively). Such a low percentage in filler content could produce lower mechanical properties and hence decreasing the fracture resistance values of Filtek™ One and vice versa for the other three resins which is in agreement with the results of the latest study.

Several studies have showed that there was a strong positive correlation between the elastic modulus of composite resins and their filler amount. Lower filler content in Filtek™ One could cause decreasing in the modulus of elasticity of the resin. Use of a material with a low flexural modulus, especially in a load-bearing area will cause reduction in their fracture resistance and a higher deformability under occlusal stresses [9, 19]. When the material is submitted to a plastic deformation, the increase in the applied load might lead to development of internal cracks. Cracks propagation can lead to both microscopic fractures of the restoration margins and a bulk fracture of the resin composite [20].

The composition of a restorative material, on the other hand, has been reported to have an imperative influence on the fracture resistance of more extensive preparations. The existence of agglomerates in a nanofiller reinforced polymer can negate the advantages of a nanofiller composite resin, because in load there may be slippage inside the agglomerate [21, 22]. The surface area for the interaction between the quantity of a polymer and the particulate matter could be reduced and the fracture can be initiated at the agglomerate sites [21-23]. Besides, the agglomerated clusters of nanofillers may have increased the crack propagation through the test specimen [22]. Since Filtek™ One is a nanofill composite, the significant decrease in its fracture resistance recorded in this study is explained by the later studies. This result is in consistent with the results of Pottmaier et al. who found that a nanoparticle composite resin presented significantly lower values of fracture resistance when compared to a nanohybrid composite resin when restoring premolars with large preparations [5].

However, the results of this study does not coincide with the results of Atalay et al. [24] who stated that the fracture resistance of endodontically treated maxillary premolars with MOD cavities restored with a nanohybrid resin
composite was not significantly different from those restored with a nanofill resin composite or a fiber-reinforced composite. This different result may be related to the difference in that the teeth in their study were endodontically treated, while in the current study only Cl II MOD cavities with no further tissue structure removal that was performed during endodontic treatment. However, Abdulhameed and Abdul-Ameer[3]stated that there was no statistical significant difference in the fracture resistance between premolars with MOD cavities restored with a nanofill resin composite and a nanohybrid resin composite, this may be related to the difference in the cavity size that was standardized to 3mm in their study while in study its 2/3 of intercuspal distance. The statistically significant increase in fracture resistance for groups B, C, and D could be related to difference in composition of each material.

Tetric EvoCeram® Bulk Fill (Group B) is a nano-hybrid composite consisting of "Bis-GMA, UDMA and Bis-EMA“ monomer with different types of "isofillers". These "isofillers" are designed especially to reduce polymerization shrinkage and hence improvement of other mechanical properties. The reduction in the inter-particle distance between the nanofiller could be the reason for high compressive strength, which lessens the tendency for crack formation and propagation. In addition, the smooth and rounded borders of the spherical nanoparticles have a tendency to dispense stress more consistently throughout the composite resin[25].Kim et al. [15]stated that composites with round particles may exhibit increased mechanical strength.

Beautifil–BulkFill composite (Group C) is a giomer material (Glass ionomer+polymer). It has been introduced as a true hybridization of glass ionomer and composite resin, which contains surface pre-reacted glass ionomer (SPRG) filler particles within the resin matrix. The S-PRG technology not only provides the advantages of mechanical strength of the composite material, but also enhance the release of several ions[26].Ilie and Fleming, [27]stated that the high-viscosity bulk-fill giomer showed improvement in the micromechanical properties compared to the conventional composite materials. However, this result inconsistent with those by Hegde and Sali, [7]as they reported that high-viscosity bulk-fill giomer showed statistically lower fracture resistance values than high-viscosity bulk-fill nanocomposite when restoring maxillary premolar teeth with MOD cavity preparation. As they stated that the highest filler loading of giomer in comparison to the tested nanocomposite materials may impede adequate light penetration and consequently reduced the degree of conversion, leading to incomplete polymerization.

Alert composite (Group D) has fiber fillers of about 20-60 µm in length. These fiber fillers could have a reinforcing effect based on stress transfer from the polymer matrix to fibers in addition to the individual behavior of fibers that act as a crack stopper. A previous study by Garoushi et al. [28]showed that short fiber fillers could stop the spread of crack and provide increase in fracture resistance of the composite resin. Random fiber orientation and a polymer matrix by a semi-IPN structure, was likely to play a major role in the mechanical properties of a resin[28]. In addition to the toughening mechanism of the fibers, the linear polymer chains of "PMMA" in a cross-linked matrix of "Bis-GMA-TEGDMA“ plasticize the polymer matrix to a certain extent, and hence increase the fracture toughness of the composite resin[14].

The results of fracture mode for this study showed a statistically non-significant difference among the four restored groups. Therefore, the second null hypothesis of this study was accepted. All the restored groups showed mostly a mixed type of mode of failure. Such a result might be related to the high bond strength of the adhesive system used in this study which was a selective etch with a Single Bond Universal Adhesive. Pouyanfar et al. [29]found that Single Bond Universal witha selective etching produced higher microtensile bond strength which exceeded the bond strength of Adper Scotchbond, Single Bond, Scotchbond Universal without an etchant step, and Clearfil SE Bond.

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Moreover, Jacker-Guhr et al.[30] showed that the higher bond strengths are often associated with mixed or cohesive mode of failures in the dentin or composite. These results support the result of this study since higher percent of mixed mode of failure were recorded and to a lesser extent cohesive within the tooth structure.

It seems, according to the results of this study, that comparison between the materials with different composition and chemistry is hard. Each material has its own characteristic that is depending of its unique content in the organic and inorganic phases. Differences in fracture resistance achieved in this study for the teeth restored with the different bulkfill composite materials are showed to be material-dependent.

CONCLUSIONS

Within the limitations of this study, all the restored premolars with extensive MOD preparations were compromised compared with sound teeth. There was no significant difference in fracture resistance of teeth restored with nanohybrid(Tetric EvoCeram®), giomer(Beautifil®), fiber–reinforced composites(Alert). However, nanofill composite (Filtek™ One) produced the least fracture resistance compared with the other restored teeth with statistically significant differences.

REFERENCE

Ismail & Abd-Alla (2020): Resistance of premolars with bulk fill composite materials


