Effects of Curing Time on Compressive Strength of Hybrid Ionomer
(In Vitro Study)

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Abstract

Objective: The aim of this study was to investigate the compressive strength of hybrid ionomer with different curing times which are 20 seconds, 30 seconds, 40 seconds and 50 seconds.

Methods: This was an experimental laboratory study with posttest only group design. With the total of 24 samples of hybrid ionomer specimens with disk shape (5mm in diameter and 2mm in thickness) were prepared and polymerized using Quartz Tungsten Halogen (QTH) for each group (n=6) of different curing times 20 seconds, 30 seconds, 40 seconds and 50 seconds respectively. All samples were immersed in distilled water with a dark container and stored in incubator at 37°C for 24 hours before the test. Compressive strength test was done by Universal Testing Machine with crosshead speed of 0.5mm/min. All data were analyzed by one way - ANOVA.

Results: The mean and standard deviation of the compressive strength of hybrid ionomer with the curing times 20 seconds, 30 seconds, 40 seconds and 50 seconds were 45.6± 0.4648MPa, 46.8 ± 0.8165MPa, 48.5 ± 0.4037MPa, 50.2 ± 0.5193MPa respectively. Statistic analyze showed there was significant difference between the effect of curing time of the compressive strength of hybrid ionomer.

Conclusion: The increase of curing times will result an increase of compressive strength of hybrid ionomer.

Keywords: curing times, compressive strength, hybrid ionomer

Introduction

Hybrid ionomer developed to improve the limitation of glass ionomer cement and composite resins. In another word, the purpose to develop hybrid ionomer is to remain the characteristic of fluor releasing in glass ionomer cements and cover up the disadvantages of it with the addition of composite resins. In the year of 1980, hybrid ionomer was first introduced as Vitrebind Liners/ Base (3M) in powder and liquid system. The powder consists of Fluor aluminosilicate glass with photo initiator and chemical initiator whereas the liquid consists of 15 to 25 percent of hydroxyl ethyl methacrylate resin component with photo initiator and water. After several years, hybrid ionomer continues to developed to as a restoration that are widely used in dentistry.

Hybrid ionomer polymerized through three methods which are chemical polymerization, light polymerization and dual cured which are the combination of chemical and light. Adequate polymerization is the key to obtain the maximum result of physical and chemical characteristics of resin base materials.

Factors that affecting the polymerization of the hybrid ionomer includes the thickness of the specimen, light intensity, wavelength, exposure time, location and orientation of the tip of the source. In the study of Parisay I et al who reported that the increase of curing times (20, 30 and 40 seconds) will result an increase in the mechanical properties of hybrid ionomer which is microhardness. One of the materials’ characteristic that act as an indicator for the success of a restorative is compressive strength due to the higher the compressive strength will withstand the multi-functional forces and mastication forces.

The purpose of this study was to evaluate the compressive strength of hybrid ionomer with different curing times which is 20, 30, 40 and 50 seconds.
Materials and Method

Hybrid ionomer (Fuji II LC, GC Corp, Japan) was used in this study. The composition of the material is detailed in Table 1.

With the total of 24 samples of hybrid ionomer specimens with disc shape (5mm in diameter and 2mm in thickness) were prepared using a stainless steel mould. Hybrid ionomer were handled according to the manufacturer’s instructions. The powder and liquid (0.25g: 0.06g) of hybrid ionomer were mixed thoroughly on paper pad then placed into the mould whereas bottom and top of the mould were layered with cellophane strips and glass slides. Polymerization was done using light curing unit Halogen (Denta America, Litex 680A, USA) for each group (n=6) of different curing times 20 seconds, 30 seconds, 40 seconds and 50 seconds respectively. All samples were immersed in distilled water with a dark container and stored in incubator at 37°C for 24 hours before the compressive test.

The compressive strength was done using universal testing machine (Torsee, Japan) with a maximum compression of 200kgf and a crosshead speed of 0.5mm/min.

The data were analyzed statistically by one way-ANOVA.

Table 1. Composition of hybrid ionomer (Fuji II LC, GC Corp, Japan)

<table>
<thead>
<tr>
<th>Powder</th>
<th>Liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>fluoroaluminosilicateglass</td>
<td>Distilled water (CAS 7732-18-5)</td>
</tr>
<tr>
<td>100%</td>
<td>20 - 30%</td>
</tr>
<tr>
<td>polyacrylic acid (CAS 9003-01-04)</td>
<td>20-30%</td>
</tr>
<tr>
<td>Urethane dimethacrylate (CAS 72869-86-4)</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Camphor quinone (CAS 465-29-2)</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

Result

The compressive strength of the hybrid ionomer was shown increased with the increase of curing times. The mean and standard deviation of the compressive strength of hybrid ionomer with the curing times 20 seconds, 30 seconds, 40 seconds and 50 seconds (Table 2) were 45.6 ± 0.4648MPa, 46.8 ± 0.8165MPa, 48.5 ± 0.4037MPa, 50.2 ± 0.5193MPa respectively.

The result of the statistical analyzes showed that there was a significant difference (p<0.05) therefore the hypothesis was rejected which means curing times had effect on compressive strength of hybrid ionomers.

Table 2. Mean, standard deviation (sd) and significance (p) of hybrid ionomer of compressive strength with different curing times

<table>
<thead>
<tr>
<th>curing times</th>
<th>Mean±SD Compressive strength (MPa)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>20’</td>
<td>45.6±0.4648</td>
<td>0.00</td>
</tr>
<tr>
<td>30’</td>
<td>46.8±0.8165</td>
<td></td>
</tr>
<tr>
<td>40’</td>
<td>48.5±0.4037</td>
<td></td>
</tr>
<tr>
<td>50’</td>
<td>50.2±0.5193</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

Compressive strength is an important indicator to evaluate the mechanical characteristics of a restorative material because the process of mastication is always referred as a natural compression. Bayindir and Yilmaz6 state that the highest compressive strength in the restorative materials is composite resins followed by amalgam, compomer, hybrid ionomer then glass ionomer cement.

From the result of this study (Table 2) shows that there is a significant difference (p<0.05) between the compressive strength and different curing times which are 20, 30, 40, and 50 seconds therefore the increase of curing times will result an increase in the compressive strength of hybrid ionomer. This result is similar to the study of Parisay I et al13 who reported that the increase of curing times (20, 30 and 40 seconds) will result an increase in the mechanical properties of hybrid ionomer which is micro hardness.

Hybrid ionomer undergo the dual cured process which includes chemical/self-cure and light cure and when the material was cured with the light, the heat produced from the light curing unit will increase the self-cure in the process of polymerization of hybrid ionomer and the mechanical properties.15

Factors that affecting the polymerization of the hybrid ionomer includes the thickness of the specimen, light intensity, wavelength, exposure time, location and orientation of the tip of the source. Adequate polymerization is an important factor in obtaining the maximum mechanical properties of the resin based material. Inadequate of polymerization will result in discoloration, pulp irritation and failure in restoration.9 Polymerisation of hybrid ionomer consists of two reactions: the acid base reaction and the free radical reaction. The free radical reaction is the polymerization of hydroxyl etil methacrylate (HEMA) and the cross-link agent which are responsible in the oxidation and reduction reaction. This reaction will then have formed a hydrogen bond in between the HEMA polymer and polycarboxylic acid.1-5 If the photoinitiator does not absorb enough photons at an appropriate wavelength, polymerization may be impaired.16

Previous study by Alpo AR et al9 founded that there was no significant difference between the compressive strength of hybrid ionomer with the different curing times of 20 seconds and 40 seconds neither with light emitting diodes nor halogen. In the contrary, this study was found
significant difference (p<0.05) in compressive strength of hybrid ionomer with the curing times 20,30,40 and 50 seconds by using light curing unit halogen. Alpoz then explained it is important to increase the light curing time and use appropriate light curing devices to polymerize and to maximize the hardness and compressive strength of restorative materials.

It was reported that process of light curing is influenced by the light intensity, time, and output power density used, which consequently influence the mechanical properties of resin materials. Silva CM et al. concluded that the compressive strength of the composite resin light-cured with either a halogen lamp or a LED source was similar. There was literature shown the chemical composition of dental composites interfere in their mechanical properties. The increase in light intensity and curing times will result the monomer reaction stable and it will increase the mechanical properties of a material.

Conclusions

In conclusion, the increase of curing times will result an increase of compressive strength of hybrid ionomer.

References