A COMPARISON OF POLYMERIZATION BY LIGHT EMITTING DIODE AND HALOGEN BASED LIGHT CURING UNITS ON HYBRID AND NANO COMPOSITES - AN IN VITRO STUDY

INTRODUCTION

Resin based composites have currently emerged as the most frequently used esthetic restorative material in dentistry. Methods and devices to cure these resins have also evolved jointly, progressing from chemical cure to modern forms of light curing. In general, total energy—the product of light intensity and exposure time—determines the mechanical properties of the resin composites. If the amount of light reaching the resin composite is reduced, the depth of cure could be decreased.1 The surface hardness of dental composites is often used to measure the curing ability of LCUs2 and the depth of cure of resin composites.2,3 The surface hardness of resin composites correlates with the degree of monomer conversion4 and is therefore used as an indirect measurement of curing depth in the present study. Knoop hardness measurement is one of the several suitable methods available for the determination of the surface hardness.

AIM: To evaluate the top and bottom hardness of Hybrid and Nano composites polymerized with Halogen based and Light emitting diode light curing unit and Variation in duration of exposure.

MATERIALS AND METHODOLOGY: Sixty Hybrid resin based composite and sixty Nano composite specimens fabricated in 8mm x 2mm stainless steel molds were used for this study. Using two different light curing units: Halogen Based and Light Emitting Diode. Two posterior restorative composites (Filtek Z250, 3M ESPE and CeramX DENTSPLY) of B2 shade and two light curing units (LCUs) were selected for this study. LED (Gnatus), Halogen (Curex).

RESULTS AND CONCLUSION: Results showed that the hybrid and nano resin based composite, for all top and bottom hardness, the hybrid resin based light curing units produced higher knoophardness. For group A, B, C, D.From this study we can conclude that the effect of duration for exposure, presents no significant difference with respect to curing units and type of resin based composites in all groups.

KEYWORDS

Hybrid Resin Based Composite, Nano Composite, Halogen Based Light Curing Units, Light Emitting Diode

Table 1: Two curing regimens were examined using these curing units

<table>
<thead>
<tr>
<th>Light-curing units</th>
<th>Type</th>
<th>Tip (mm)</th>
<th>Energy consumption</th>
<th>Power density (mW/cm3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curex</td>
<td>Halogen</td>
<td>8</td>
<td>80w</td>
<td>900</td>
</tr>
</tbody>
</table>
60 Hybrid resin based composite (Filtek Z250 3M ESPE) and 60 Nano composite specimens fabricated (CeramX, Dentsply), in 8mm x 2mm stainless steel molds were taken for study. Using two different light curing units:
1) Halogen Based
2) Light Emitting Diode

To prepare each specimen, the inner wall of the molding was coated with petroleum jelly to facilitate easy removal of composite after curing. The composites were placed into the mold using plastic filling instrument confined between two opposing acetate strips. The mold along with composite were placed on a clear polyester sheet on a flat glass slab, covered with another clear polyester sheet supported by a thin, clear cover glass to ensure the sample is flat. The top surface was polymerized for 20/40/60seconds according to the division of each subgroup as shown in table 2.

The top surface was identified with an indelible marker, and after polymerization the clear polyester strips were removed and flash material was cut out using a Bard Parker blade no. 15 following which the samples were retrieved from the mold.

Then specimens were stored in dry lightproof container. Twenty-four hours later indentation was tested using knoop hardness tester of 100gm load and a dwell time of 10 second. The top and bottom surface was measured. To ascertain the percentage of depth cure, the bottom surface hardness values were divided by top surface hardness values and multiplied the result by 100.

Data was analyzed using SPSS (Statistical Package for Social Sciences) for Windows release 11.5 (SPSS, Chicago, IL, USA). Two-way ANOVA was used to find the differences between the groups. The interaction effects were tested by scheffe’s multiple comparison test.

### Table 2: The surface will be polymerized for 20/40/60seconds according to the division of each subgroup.

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Group-I Halogen</th>
<th>Group-II-Light Emitting Diode (LED)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subgroup A - Hybrid resin</td>
<td>Division 1 - 20sec</td>
<td>Division 1 - 20sec</td>
</tr>
<tr>
<td></td>
<td>Division 2 - 40sec</td>
<td>Division 2 - 40sec</td>
</tr>
<tr>
<td></td>
<td>Division 3 - 60sec</td>
<td>Division 3 - 60sec</td>
</tr>
<tr>
<td>Subgroup B - Nano resin</td>
<td>Division 1 - 20sec</td>
<td>Division 1 - 20sec</td>
</tr>
<tr>
<td></td>
<td>Division 2 - 40sec</td>
<td>Division 2 - 40sec</td>
</tr>
<tr>
<td></td>
<td>Division 3 - 60sec</td>
<td>Division 3 - 60sec</td>
</tr>
</tbody>
</table>

### RESULTS:
**COMPARISON BETWEEN MATERIAL:**
Overall results showed that the hybrid and nano resin based composite, for all top and bottom hardness, the hybrid producing much higher knoop hardness. (table 3 and graph 1).

**COMPARISON BETWEEN LIGHT CURING UNITS:**
Overall results showed that the halogen based light curing units producing harder top and bottom resin based composite surface than light emitting diode curing units. (table 4 and graph 2).

The main effect of duration for exposure, presents no significant difference with respect to curing units and type of resin based composites.

### Table 3: Knoop hardness mean and standard deviation values by surface and groups.

<table>
<thead>
<tr>
<th>Side</th>
<th>Group</th>
<th>Summary</th>
<th>Halogen</th>
<th>LED</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>Hybrid</td>
<td>Means 29.5180</td>
<td>22.514</td>
<td>23.516</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Std.Dev.</td>
<td>4.4787</td>
<td>2.3926</td>
<td>3.0686</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Std.Dev.</td>
<td>2.9664</td>
<td>1.4599</td>
<td>4.9956</td>
<td></td>
</tr>
<tr>
<td>Bottom</td>
<td>Hybrid</td>
<td>Means 23.3705</td>
<td>19.469</td>
<td>19.919</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Std.Dev.</td>
<td>4.7484</td>
<td>2.2984</td>
<td>3.5902</td>
<td></td>
</tr>
<tr>
<td>Nano</td>
<td>Means 20.7480</td>
<td>13.870</td>
<td>13.809</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Std.Dev.</td>
<td>3.4757</td>
<td>2.2581</td>
<td>2.8568</td>
<td></td>
</tr>
<tr>
<td>Ratio</td>
<td>Hybrid</td>
<td>Means 90.2383</td>
<td>78.531</td>
<td>84.384</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Std.Dev.</td>
<td>2.7668</td>
<td>6.9464</td>
<td>7.8980</td>
<td></td>
</tr>
</tbody>
</table>

### Graph 1: Comparison of halogen and Led groups with respect to composites (% of ratio between bottom and top surface values)

### Graph 2: Comparison of halogen and Led groups with respect to duration (% of ratio between bottom and top surface values)

### DISCUSSION
The ability of LCUs (Light Curing Units) to deliver enough light at appropriate absorption maximums for the respective photo initiators systems in resin-based composites is crucial to optimize the physical properties of light-activated dental materials. Inadequate polymerisation of resin based composites has been associated with inferior physical properties, retention failures, higher solubility and adverse pulpal response to unpolymerised monomers.

Visible light activated resin systems use a diketone absorber to create free radicals that initiate polymerization. Most dental photo initiator system use camphoroquinone as the diketone absorber with the absorption maximum in the blue region of the visible light spectrum at a wavelength of 400 to 500nm.

The effectiveness of composite cure may be assessed directly or indirectly. Direct methods such as Fourier Transform Infrared spectroscopy (FTIR) and Laser Raman spectroscopy assess the true degree of monomer conversion. These methods are not viable for routine use as they are complex, expensive and time-consuming. Indirect methods include scraping and hardness testing. The scraping method has shown to overestimate the depth of cure.
the bottom surface should be at least 80% as hard as the top surface. The only LCU to exceed 80% is the halogen based (curex) light curing unit.

In this study, the variation of duration for exposure, does not significantly differ with respect to curing units and type of resin based composites. As it is better to cure according to the manufacturer’s recommendation.

Overall results of the study showed that the hybrid and nano resin based composite, for all top and bottom hardness, the hybrid producing much higher knoop hardness. This is in agreement with findings of other investigators (Phillips, 1991: Sturdevant, 1995). It is believed that larger particle size and the higher loading percent of the hybrid composite resin compared to that of the nano contributes to this increase in polymerization.

However, the effectiveness of cure cannot be assessed by top surface hardness alone, as this does not predict the hardness at the bottom surface of the restoration (12). Studies have shown that as light passes through the bulk of restorative material, its intensity is greatly decreased due to light absorption and scattering, thus decreasing the potential to cure. Hence the bottom surface hardness will be affected more than the top surface. Therefore it is important to evaluate the bottom surface hardness also (14).

Results of this study showed that the halogen based light curing units produces harder top and bottom resin based composite surface compared to light emitting diode curing units (p < .0001).

Hofmann et al in 2002 have shown that LED light units with relatively low irradiance of narrow spectral range presented low power output, may result insufficiently cured composites and therefore, inferior mechanical properties of the restoration (19).

Few studies revealed significant difference among LED light curing units to cure the top and bottom surface of a 2mm thick composite specimen. All LEDs tested produced a lower surface hardness than did the Optilux 501 halogen light (18).

When clinically considered that poorly polymerised resin can lead to undesirable consequences such as gap formation, marginal leakage, recurrent caries, adverse pulpal effects, and ultimate failure of the restoration. Bottom hardness greatly influences the long term prognosis of a restoration (20).

CONCLUSION:
This in vitro comparison study concluded that:
- The halogen based light curing units produces significantly harder top and bottom resin based composite surfaces then the LED light curing units.
- When compared with resin based composites, hybrid produced more harder surface then nano composite, regardless of light curing units.
- Effect of duration for exposure in this study presents no significant difference with respect to curing units and type of resin based composites.

REFERENCE: