Surface hardness of a resin composite cured with a transparent cone

Paula Drexler, DDS  Franklin García-Godoy, DDS, MS  Juan R. Boj, DDS, MS

Abstract

The purpose of this study was to evaluate the surface hardness of a resin composite (TPH) polymerized with and without the use of a transparent light-curing cone. Twenty composite blocks were made on a Teflon® mold with cylindrical holes of 3 mm depth and 6 mm radius, and were light cured following different procedures:

Group 1: Ten samples were pressed with a glass slide and light cured for two 40-sec exposures without the plastic cone.

Group 2: Ten samples were light cured using the transparent plastic cone which was pressed down into the composite until the tip was 1 mm from the floor of the cylindrical Teflon mold. The curing light was activated for 40 sec. The cone was then removed and the remaining part of the mold was filled in one portion, pressed with a glass slide, and light cured for 40 sec.

After curing, the samples were placed in distilled water for 48 hr. The hardness of the samples was then measured with a Rockwell Hardness Tester at three different points on each composite block; therefore, 30 measurements per group were taken.

The data were statistically analyzed using an unpaired Student’s t-test. The results revealed that the resin composite cured with the transparent plastic cone had a statistically significant higher surface hardness value (P<0.0001) than the group cured without the cone. (Pediatr Dent 19:419–20, 1997)

Resin composites with incomplete polymerization exhibit poor mechanical and chemical properties. In order to increase resin polymerization, several techniques have been proposed such as application and curing in small increments, curing from buccal and lingual directions through part of the enamel, use of translucent matrix bands and light-transmitting wedges, use of mirror matrix bands, and the use of a transparent cone attached to the end of the curing wand, which is then inserted into the bulk of the resin.

The purpose of this study was to evaluate the surface hardness of a resin composite polymerized with and without the use of a transparent light-curing cone.

Materials and methods

Twenty composite blocks (TPH, LD Caulk Co., Milford, DE) were made on a Teflon mold with cylindrical holes of 3 mm depth and 6 mm radius, and were light cured (Optilux 400, Demetron, Danbury, CT) following different procedures:

Group 1: Ten samples were pressed with a glass slide and light cured for two 40-sec exposures without the plastic cone.

Group 2: Ten samples were light cured using the transparent plastic cone (Light-tip CDB, Huddinge, Sweden) which was pressed down into the composite until the tip was 1 mm from the floor of the cylindrical Teflon mold. The curing light was activated for 40 sec. The cone was then removed and the remaining part of the mold was filled in one portion, pressed with a glass slide, and light cured for 40 sec.

After curing, the samples were placed in distilled water for 48 hr. The hardness of the samples was then measured with a Rockwell Hardness Tester (Wilson Instruments, American Chain & Cable Company) at three different points on each composite block; therefore, 30 measurements per group were taken.

The data were statistically analyzed using an unpaired Student’s t-test.

Results

The results are displayed in the Table. The resin composite cured with the transparent plastic cone had a statistically significant (P < 0.0001) higher surface hardness value than the group cured without the cone.

Discussion

The polymerization of composite resins always results in contraction and this contraction is less evident closer to the light source. The use of the cone pushes the resins towards the cavity walls (reducing the bulk of resin cured), therefore, a smaller contraction gap may be produced as well as a reduced number of porosities.

The hardness test has been used as a method to evaluate polymerization and depth-of-cure of resin composites and has been correlated to the number of remaining double bonds. One study has shown that surface hardness cannot be used to assess the quality of a curing unit.

Studies have shown that hardness, tensile strength,
clinical performance. The increased hardness obtained with the use of the transparent plastic cone attached to the wand of the curing light significantly increased the surface hardness of the resin composite tested.

The increased hardness obtained with the use of the transparent cone in our study agrees with others\(^\text{10}\) and may be due to the higher degree of conversion and cross-linking in the resin. Surface hardness does not guarantee an acceptable depth-of-cure. Once the maximum level of cure has been achieved in the upper layers of the resin, it is difficult to extend cure at the lower layers by extending time, because the light simply cannot reach them.\(^\text{11}\) Because of this, the incremental resin placement technique light-cured for 40 sec or the use of the plastic translucent cone is recommended to permit light penetration to the deepest portion of the resin. This is important in deeper restorations.

The results of this study should be interpreted with caution and should only be limited to the surface hardness of the resin. Previous studies have demonstrated that the assessment of surface hardness cannot distinguish between a well-cured and an inferiorly cured resin.\(^\text{11,16}\) Therefore, surface hardness does not necessarily indicate that an effective cure in the bulk of the resin has taken place.\(^\text{11}\)

Many years ago, Leinfelder et al.\(^\text{17}\) and Wilder et al.\(^\text{18}\) demonstrated that light-cured resins revealed increased wear resistance on the occlusal surface compared with autocured resins; these results were probably because of the increased surface hardness obtained with light-curing. This also increases the resistance to abrasion by food.\(^\text{19}\) From a practical standpoint, using the light intensity tester (radiometer) before light-curing can predict the degree of conversion of a resin,\(^\text{15,20}\) and, based on our results, using the transparent cone will increase surface hardness and may improve the clinical wear of the resin composite. The combination of the two procedures would increase the mechanical and chemical properties of the resin, improving its clinical performance.

### Table. Mean Rockwell Hardness Values for the Different Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Curing Time</th>
<th>No of Samples</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>With cone</td>
<td>80 sec</td>
<td>10</td>
<td>63.52*</td>
<td>4.89</td>
</tr>
<tr>
<td>Without cone</td>
<td>80 sec</td>
<td>10</td>
<td>49.25</td>
<td>6.15</td>
</tr>
</tbody>
</table>

\(^*\) Statistically significantly different \((P < 0.001)\).