The Effect of Storage Conditions on Dimensional Changes of Acrylic Post-Core Patterns

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Abstract:
Objective: The purpose of this study was to evaluate and compare the effect of storage time and conditions on dimensional stability of acrylic patterns.

Materials and Methods: In this in vitro study, a cylindrical shaped metallic post-core was fabricated. Impressions were made from this metallic model and 30 samples were prepared with Duralay acrylic resin. The specimens were divided into three groups of ten. Groups A, B and C were stored in dry atmosphere at 25°C; 100% humidity at 25°C; and water placed in the refrigerator at 4°C, respectively. In each sample post length, post diameter and core diameter were measured at baseline, 24 hours and 48 hours after storage. All measurements were performed in an optical measurement device. Data were analyzed using the Rank regression test.

Results: The type of dimensional changes seen in this study was shrinkage. A significant difference in post diameter was found between group B and the other two groups (P=0.001). Storing time significantly affected post diameter (P<0.001), but not post length and core diameter.

Conclusion: Within the limitation of this study, the best condition for storing Duralay post core patterns was found to be 100% humidity at 25°C for 24 hours. Storage time was also shown to have a negative effect on dimensional stability of Duralay post core patterns, in all three groups.

Key Words: Dimensional changes, Post, Duralay

INTRODUCTION
Teeth play an important role in masticatory functions and facial esthetics. Loss of the entire crown or part of it can cause disturbances in both aspects. Therefore any kind of alteration in size, shape, structure or number of teeth should be restored with appropriate prosthesis. A two part casting restoration has been introduced for the ideal replacement of severely damaged teeth [1]. Problems like lack of fitness of the restoration margins can cause caries and periapical lesions. Disproportionate post-cores, especially in relation to the size of the root canal are considered as one of the major reasons for vertical root fractures (VRF). These issues emphasize the use of high-quality materials with maximum dimensional stability and accuracy for the fabrication of post-cores. Duralay, an autopolymerized acrylic resin, has been introduced for this purpose. [1,2].

One of the disadvantages of conventional autopolymerizing resins is their dimensional inaccuracy which depends on storage time and media. In most instances a considerable amount of time elapses between the fabrication
of the acrylic pattern and initiation of the investment and casting process [3]. Different materials are used for indexing, such as plaster of Paris and sticky wax [4,5]. Patterson [6] described a method of indexing with acrylic resins in 1972. Mojan et al [7] evaluated the dimensional changes of two self-curing acrylic resins. They found a volumetric shrinkage of 7.9% for Duralay and 6.5% for Palavit G resin, and showed that 80% of the changes occurred before 17 minutes at room temperature. Dixon et al [8] studied linear changes and tensile resistance of Duralay resin, Relate resin and Zapit cianoacrylate. A significant difference was not observed between the 3 materials. Iglesia et al [9] demonstrated equal or better marginal fit for light-polymerized deacrylate resins compared to wax or Duralay. They were also found to be less affected by placement technique and storage. Cahi et al [3] investigated the dimensional stability of Type II blue inlay casting wax, Duralay and Modilux, stored for different periods of time. They recommended that Duralay and Modilux (a light curing resin) should be used as inlay pattern materials, especially if a delay in investing is anticipated. Hoshiai et al [10] compared Unifast II autopolymerized acrylic resin with four autopolymerized resins including Unifast, Curefast, ADFA and MIKY in terms of color and dimensional stability. Unifast II exhibited less marginal gap compared to the others but its clinical performance was still weak. Wang et al [11] studied the effect of processing methods on linear dimensional changes and water sorption of dentures. A significant difference in shrinkage was not found between air oven-processed and water bath-processed acrylic resin dentures. De la Cruz et al [12] compared standard impressions with verification jigs made of GC pattern resin, Duralay resin and Triad gel resin. The results did not indicate improvement in the accuracy of stone casts following jig fabrication.

We were not able to find similar studies on the dimensional changes of Duralay (Reliance, Dental Mfg. Co., USA) acrylic resin after finishing the castable post-core pattern. The purpose of this in vitro study was to evaluate the effect of storage time and conditions on dimensional stability of acrylic post core patterns.

**MATERIALS AND METHODS**

Duralay (Reliance, Dental Mfg. Co., USA) is the commercial name of a self-cure acrylic resin that can be used as recording, pattern and index material.

In this in vitro study, a cylindrical shaped metallic post-core was fabricated. The core was 6 mm in diameter and 8 mm in length and the post was 12 mm long with a diameter of 2 mm. An impression was made from the metallic model with a condensational silicone impression material (Speedex, Coltene, Switzerland) and poured with Duralay. To reduce the risk of bubble formation on the acrylic pattern, a vibrator was used during impression pouring. After complete setting of the Duralay, the model was gently removed from the impression. Thirty acrylic patterns were made with the same method and each sample was coded. They were then separately placed in an optical measurement device (Baty, England). In this device (Figure 1), a shadow of the object is formed on a scaled screen with a predetermined magnification, so that a two dimensional measurement may be made. Measuring angular and linear dimensions of industrial pieces can be performed with a precision of about 0.001 mm (1 micron).

Each sample was measured three times. The first measurement was done immediately after fabrication of the acrylic patterns to record the exact dimensions of each pattern. Post length, post diameter and core diameter were measured (Figure 2). Afterwards the 30 acrylic samples were divided into three groups of ten. Each group was stored in a different medium...
for 24 hours. Group A was stored in a dry atmosphere at 25°C, group B in 100% humidity at 25°C, and group C in water placed in the refrigerator at 4°C. All measurements were repeated at the same specified points. The samples were then placed in the same media for another 24 hours, and measured for the third time. Data were analyzed using the Rank regression test.

RESULTS
The mean value of the dimensional changes in post diameter, post length and core diameter

Table I: The mean value of dimensional changes in the studied groups.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group</th>
<th>After 24 hours</th>
<th>After 48 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Diameter</td>
<td>A</td>
<td>0.055 (0.118)</td>
<td>0.195 (0.174)</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>0.050 (0.172)</td>
<td>0.063 (0.132)</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>0.056 (0.102)</td>
<td>0.100 (0.130)</td>
</tr>
<tr>
<td>Post Length</td>
<td>A</td>
<td>0.873 (0.910)</td>
<td>1.070 (1.320)</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>0.472 (0.766)</td>
<td>0.447 (0.694)</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>0.206 (0.270)</td>
<td>0.256 (0.582)</td>
</tr>
<tr>
<td>Core Diameter</td>
<td>A</td>
<td>0.159 (0.406)</td>
<td>0.154 (0.458)</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>0.315 (0.588)</td>
<td>0.311 (0.334)</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>0.243 (0.454)</td>
<td>0.137 (0.224)</td>
</tr>
</tbody>
</table>

The only significant difference was found between group B and the other two groups in post diameter (P=0.001).

After 24 hours the least dimensional changes were seen in group B. Storing time significantly affected (P<0.001) post diameter (Table II), but not post length and core diameter.

DISCUSSION
Most studies on Duralay, have evaluated its precision as an indexing material, but its application in the fabrication of a castable post-core pattern and dimensional stability have not been extensively investigated. It has been shown that one of the main causes of vertical root fracture is the insertion of cast post-cores due to a wedging effect and increased

Table II: Rank regression coefficients due to effects of storage conditions on the post diameter (*: This parameter is set to zero because it is redundant).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Rank regression</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>0.698</td>
<td>0.208</td>
</tr>
<tr>
<td>Group B</td>
<td>-1.89</td>
<td>0.001</td>
</tr>
<tr>
<td>Group C</td>
<td>0*</td>
<td>-</td>
</tr>
<tr>
<td>After 24 hour</td>
<td>-1.98</td>
<td>0.000</td>
</tr>
<tr>
<td>After 48 hour</td>
<td>0*</td>
<td>-</td>
</tr>
</tbody>
</table>
cement hydraulic pressure. Therefore, precise fabrication of an acrylic post-core with an acceptable pattern and the stability of its dimension during investing, burn out and casting can significantly affect the reduction of vertical fractures.

After 24 hours, the mean dimensional changes in post diameter were similar in groups A and C. However, after 48 hours these changes were greater in group A as compared to group C. According to the findings presented in Table 1, the least mean values of diameter changes were found in group B.

In both measurements, the highest and lowest mean values of dimensional changes in post length were found in groups A and C, respectively. The mean dimensional changes in group B was lower than group A and higher than group C.

In contrast to post dimensions, the maximum mean value of core diameter changes were found in group B, at 24 and 48 hours. The least mean value of core diameter after 24 hours was observed in group A and after 48 hours was seen in group C.

The least dimensional changes occurred in group B after 24 hours and the maximum dimensional changes were seen in group A after 48 hours. The present study showed that time had a negative effect on the dimensional stability of Duralay post core patterns.

CONCLUSIONS
Within the limitation of this study, the best condition for storing acrylic post core patterns is 100% humidity at 25°C for 24 hours, and the most unsuitable is dry medium at 25°C for 48 hours. Wong et al [11], noted that acrylic resins had a tendency to absorb water and consequently exhibit shrinkage during setting. Expansion following water absorption can compensate for a part or all of the polymerization shrinkage. This can explain the least amount of dimensional changes observed in group B. The type of dimensional changes seen in the present study was shrinkage, which was similar to previous studies conducted on acrylic resins. We also demonstrated that dimensional changes were minimized when Duralay post-core patterns were stored in wet medium at 25°C. This was in accordance with other investigations that used Duralay as the study material [6,8].

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REFERENCES