An in vitro study to compare the dimensional accuracy of commercially available heat cure denture processing materials at the posterior palatal seal area

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Abstract

Background: Posterior palatal seal area which is the most posterior limitation of maxillary denture base has a greater contribution for retention in maxillary complete denture. The material aspect that is the heat cure denture base materials used for fabrication of final prosthesis is also equally important for clinical success. These materials may show variation in their properties such as strength and dimensional stability. These dimensional changes occurred are may be due to the combined result of both polymerization shrinkage and stresses released during flask cooling and it further may alter the pattern of dimensional acrylic resin behavior.

Aims and Objectives: The aims and objectives of the study was to evaluate and compare the dimensional accuracy of various heat polymerizing materials on the posterior palatal seal area.

Materials and Methods: Four commercially available heat cure denture processing materials, namely, Lucitone (Dentsply), Dental products India (DPI), Viracryl, Trevalon (Dentsply) were used as testing materials. An ideal edentulous Class I maxillary stone mold is taken as master die. A total of 20 samples were taken and were divided into four groups of five each. The dimensional changes were assessed at five different points marked at the posterior palatal seal area using a digital caliper with an accuracy of 0.01 mm.

Results: Statistical analysis was performed by IBM SPSS version 21 using Kruskal–Wallis test, and the statistical significance was defined at $P < 0.01$. The mean marginal increase was 2.61 mm for DPI, 1.64 mm for Lucitone, 1.94 mm for Viracryl, and 1.34 mm for Trevalon.

Conclusion: Within the limitations of this study, it was concluded that the dimensional accuracy of dentures is influenced by the type of heat cured materials used. In this study, Trevalon exhibited minimal discrepancy while DPI showed the highest discrepancy among the groups with statistically significant difference between the materials.

Introduction

A well-adapted denture base to oral tissues through the forces of adhesion, cohesion and surface tension helps to attain retention, stability of the denture.¹ ² Posterior palatal seal region is considered to be the most crucial area in relation to denture base retention. Posterior or palatal seal area creates a partial vacuum beneath the denture base which has a wide range of advantages such as retention, prevention of gag reflex, and preventing food accumulation beneath the denture.³ ⁴ Materials used to fabricate the denture base is also equally important for the success of the denture. The most commonly used material in denture reconstruction is acrylic with a majority of dentures being fabricated using polymethyl methacrylate having optimal physical properties, excellent esthetics with relatively low toxicity compared to other plastic denture base materials.⁵ Compression molding technique with heat activation in a tempered water bath for resin polymerization is the conventional method being followed for processing the dentures. However, polymerization shrinkage and dimensional changes of denture bases may occur.
during polymerization process which is inevitable and have been well documented in the literature.\(^5\) Conversely, the distortion resulting from flask cooling and stone cast deflasking induce stresses released during the base procedure.\(^6\) Consequently, the combination of polymerization shrinkage and strain release decreases the adaptation level of support tissue, influencing the base stability.\(^5\) The shrinkage resulting from the polymerization reaction is not uniform throughout but more evident on the palate of the maxillary denture and will be poorly compensated after resin base processing, which increases the gap between the denture base and underlying mucosa, compromising the fit of dentures. Posterior palatal seal region, considered to be a critical area in relation to base retention, will be hardly corrected after processing. The contraction which occurs during polymerization shrinkage is not uniform and is influenced by the thickness of the denture bases.\(^7\) Factors inherent to the physical properties of acrylic resin, technical procedures and the anatomical conditions of the patient’s mouth have been demonstrated previously in the literature.\(^8,9\) Therefore, acrylic resins with enhanced properties and innovative processing methods need to be developed to improve the dimensional stability of dentures. Thus, the purpose of this study was to verify the dimensional changes of denture bases processed with four commercial heat-cured acrylic resins at the posterior palatal seal area of the maxillary complete denture.

### Materials and Methods

An ideal edentulous Class I maxillary mold is taken and a wax spacer with four tissue stops (of 2 mm × 2 mm) is adapted on it (Figure 1). Five different points, namely, A, B, C, D and E were marked on the posterior palatal seal area and notched on the cast. Master Cast along with spacer is duplicated using polyvinyl siloxane (Dentsply) putty material (Figure 2), and the casts are poured in Type III Dental stone. On the obtained casts, a 0.5 mm thick wax sheet is adapted and flasking procedure is carried out to obtain heat cure denture bases using four different heat cure materials (Figure 3). These obtained final heat cure denture bases are adapted on the ideal edentulous model by removing the spacer over it and impression were made using light body (Dentsply) for all the denture bases (Figure 4). Five samples were made for each material, and a total of four materials were compared. The discrepancy was assessed at all five previously marked reference points for all the four different materials using Digital Vernier Callipers (Figure 5).

### Results

Results obtained were tabulated in Microsoft excel sheet, and the mean values were subjected to statistical analysis using IBM SPSS version 21; the significance was calculated using Kruskal–Wallis test at 0.01 significance (Table 1). The group fabricated with DPI material showed the highest mean gap of

**Table 1: Showing the mean and standard deviation values of four heat cure denture materials**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean±SD</th>
<th>P value</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPI</td>
<td>2.61±1.21</td>
<td>&lt;0.05</td>
<td>HS</td>
</tr>
<tr>
<td>Lucitone</td>
<td>1.64±0.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viracryl</td>
<td>1.94±0.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trevalon</td>
<td>1.34±0.89</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: Showing the mean increase in gap at five different points of four heat cure denture materials**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Points</th>
<th>Mean±SD</th>
<th>P value</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPI</td>
<td>Point A</td>
<td>2.66±1.36</td>
<td>0.81</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Point B</td>
<td>2.35±1.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Point C</td>
<td>2.44±1.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Point D</td>
<td>2.49±1.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Point E</td>
<td>3.09±1.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lucitone</td>
<td>Point A</td>
<td>1.79±0.42</td>
<td>0.19</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Point B</td>
<td>1.78±0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Point C</td>
<td>1.42±0.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Point D</td>
<td>1.36±0.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Point E</td>
<td>1.87±0.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viracryl</td>
<td>Point A</td>
<td>1.91±0.46</td>
<td>0.99</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Point B</td>
<td>1.98±0.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Point C</td>
<td>1.95±0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Point D</td>
<td>1.98±0.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Point E</td>
<td>1.90±0.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trevalon</td>
<td>Point A</td>
<td>1.43±0.29</td>
<td>0.66</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Point B</td>
<td>1.59±1.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Point C</td>
<td>1.60±1.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Point D</td>
<td>0.80±0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Point E</td>
<td>1.26±0.90</td>
<td></td>
<td></td>
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</tbody>
</table>

SD: Standard deviation, DPI: Dental product India

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**Figure 1:** Edentulous mold with spacer adapted

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**Figure 2:** Edentulous cast with spacer adapted

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**Figure 3:** Edentulous cast with spacer adapted

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**Figure 4:** Edentulous cast with spacer adapted

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**Figure 5:** Edentulous cast with spacer adapted
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Discussion

Posterior palatal seal area, being the most important area for retention of maxillary complete denture should be properly recorded and reproduced in the denture base. Literature has explained various techniques to control the deleterious effects of polymerization shrinkage affecting the dimensional accuracy of the posterior palatal seal region. The shrinkage of acrylic resin can be reduced by mechanically interlocking the resin with the cast.\[10\] The most commonly used denture base material in clinical use is the heat cure material. It involves the use of simple fabrication method, excellent color stability, and fine esthetic properties. The main drawback is the lack of dimensional stability which is widely accepted.\[11\] It is always associated with flaws of shrinkage of the acrylic resin because of the curing process. Various denture base materials and processing techniques have been introduced to produce a more accurate denture base. Wolfaard et al., in his study, stated that factors influencing the dimensional change of acrylic resin dentures as the size and shape of specimen, the thickness of the denture, the presence of teeth, and the dimensional changes that might occur during processing.\[12\] Thus, the results of the dimensional changes could be directly attributed to the acrylic resin and to the processing method. Compression molded methyl methacrylate has been the standard denture base material for more than 40 years. The conventional method is the commonly applicable method for curing acrylic resin due to its ease of handling and relatively good accuracy. Various authors in their studies considered this method as a gold standard for comparison with other techniques. Different methods - such as the use of vernier callipers, gauges, comparators, micrometers, and radiography - have been introduced in different studies to determine the dimensional accuracy of denture bases. Garfunkel employed a Digital Calliper to measure changes in vertical dimension of occlusion and processed dentures.\[13\] Lee et al. used the scanned dentures placed on the respective master casts by computerized tomography to determine the overall gap.
formation and dimensional changes of denture bases.\textsuperscript{14} Keenan \textit{et al.} compared the dimensional changes of simulated maxillary complete dentures during polymerization by the use of an internal micrometer.\textsuperscript{15} Venus \textit{et al.} showed that the processing technique, rather than the choice of the resins, seems to be the dominant variable with respect to dimensional changes.\textsuperscript{16} In this study, the dimensional changes were measured with Digital Vernier Callipers at five different points, and it was shown that the Trevalon showed the maximum dimensional stability while denture base processed with DPI showed the least stability. Arora \textit{et al.} compared the linear accuracy of different heat cure materials using Digital Vernier Callipers, namely, Meliodent, Triplex, Vertex, and Trevalon after curing and after finishing and polishing and concluded that Meliodent showed minimal discrepancy and claimed to be the material of choice for denture fabrication.\textsuperscript{17} Nair \textit{et al.} has done a comparative study of various lab techniques controlling posterior palatal shrinkage in maxillary complete denture.\textsuperscript{18} Consani \textit{et al.} in their study compared and framed the dimensional changes of four heat cure denture materials, namely, Clásico, Viperil, and Meliodent Multicyrl acrylic resins in the regions to the distal of canine area (A), mesial side of first molars (B), and posterior palatal zone (C).\textsuperscript{19} The gap between the stone cast and resin base was scrutinized with a measuring microscope at five reference positions, and small values of discrepancies were seen in the Clásico group of acrylic resin base. In this study, Trevalon showed maximum dimensional stability measured after curing.

**Conclusion**

- Taking into consideration of the limitations of the study, it was concluded that dimensional accuracy of dentures is influenced by the type of heat cured materials used
- In this study, Trevalon exhibited minimal discrepancy while DPI showed the highest discrepancy among the groups, and there was a significant difference between the materials
- Trevalon is the material of choice for denture fabrication showing maximum dimensional stability.

**References**


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