ORIGINAL STUDY

An evaluation of the hardness of flexible Denture Base Resins

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Abstract

Nylon denture base material (Lucitone FRS) was studied for its mechanical properties. The study confirmed that flexible denture base material has lower values in terms of hardness.

Introduction

Poly methyl methacrylate (PMMA) resins have dominated the denture base market for more than 50 years. This was due to PMMA's good physical properties, availability, reasonable cost and ease of manipulation. The polymerization of heat-cured PMMA is conventionally carried out in a temperature controlled water bath for several hours. This is a relatively easy process. However, there are many factors in the laboratory procedure that can lead to alteration of denture occlusion and results in significant increase in vertical dimension after processing. Also it is known for its toxicity and hypersensitivity as a result of oxidation byproducts.
The potential alternative materials to PMMA are the polycarbonates and the nylon denture base resins. Of this nylon is the generic name for certain types of thermoplastic polymers belonging to the class polyamides. These polyamides are produced by the condensation reaction between a diamine and a dibasic acid.

In the present study we have compared compression molded heat polymerized denture base material Trevalon and nylon based thermoplastic denture base material Lucitone FRS based on hardness.

**Materials and Methods**

<table>
<thead>
<tr>
<th>Materials used</th>
<th>Type of Reaction</th>
<th>Formulation</th>
<th>Batch No.</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trevalon</td>
<td>Chemical cure</td>
<td>Powder: Liquid 3.4 gms:10 ml</td>
<td>TH030703</td>
<td>DENTSPLY, Postfach 101074 D63264, Dreich Germany</td>
</tr>
<tr>
<td>Lucitone FRS</td>
<td>Chemical cure</td>
<td>Single component</td>
<td>060511B</td>
<td>DENTSPLY Trubyte, New York, PA, USA</td>
</tr>
</tbody>
</table>

*Sample preparation:* A total 12 specimens were prepared from the two different types of denture base materials namely, Trevalon and Lucitone FRS to test hardness.
**Initial specimen preparation:** The specimen preparations were carried out in accordance with the conditions laid down in ISO Specification no.1567, for denture base polymers. The master mold was made of Perspex of dimension 68 x 50 x 4 mm as shown in (Fig.1) with a slight convergence to one end. The master Perspex molds were invested in gypsum in their respective dental flasks. After the dental stone was set, the mold plates were removed to create space for packing or injecting denture base resin.

**Compression molded heat polymerized denture base material:** In the conventional compression molding technique metal flasks were employed to prepare Trevalon specimens. Mold separation, packing, clamping and curing followed standard practice. All specimens were polymerized in athermostatically controlled water bath (Model: Samit, India) according to the manufacturer’s instruction. Once the curing was over the flasks were allowed to bench cool before being deflashed. The samples were obtained from the flasks.

**Nylon denture base material:** Nylon denture base material was supplied as a single component in the cartridge form. The flask system used for the study was success injection system, Dentsply. As the nylon was being melted in a furnace which was pre-heated to a temperature of 302°C, the stone mold was exposed under the heat lamps. The mold was uniformly heated for 17 min to a temperature between 65 and 70°C. The flasks halves were assembled with brackets and together with the cartridge containing melted nylon; they were placed on to the injection unit. The injection molding pressure was maintained at 5 bars for 1 min and immediately after injection process; the assembly was removed and disengaged. The dental flask was bench – cooled for 5 min before deflasking. After divestment, the blank was removed from the mold and the sprues were separated from the blank with a cut – off disc.

**Final specimen preparation:** From each sample plate three specimen strips were prepared as in (Fig.2) by using computerized cutting machine (Model no. 2104). The specimen strips were wet ground using 600 grit silica paper. The final dimensions of the specimen were 64 x 10 x 2.5 mm. Each
specimen was individually measured using vernier caliper (Mitutoyo Digmatic caliper). All the specimens were stored in distilled water at $37 \pm 1 ^\circ C$ in an incubator for 7 days.

Parameters under which the study was done are: a) test load -50 gf b) time -15s and c) temperature – 25$^\circ C$.

**Measurement of Properties:** The samples were tested after 7 days of storing in distilled water in an incubator. They were taken out 5 minutes before the hardness test and transferred to room temperature at 18$^\circ C$. Hardness was determined by Vicker’s micro-indentation hardness test. The test was carried out on Shimadzu HM– 2000 (ASTM – E 384 – 05) as shown in (Fig.3).
Vicker’s hardness (VHN) = Load/ Area of pyramidal indentation

SAMPLE MOUNTED FOR TESTING

Shimadzu – 2000 for testing hardness (Fig. 3)

Results

The basic data and mean value of hardness for the two denture base material are as following:

<table>
<thead>
<tr>
<th>Materials</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
<th>Test 4</th>
<th>Test 5</th>
<th>Test 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trevalon</td>
<td>14.7</td>
<td>14.6</td>
<td>14.5</td>
<td>14.4</td>
<td>14.9</td>
<td>14.5</td>
</tr>
<tr>
<td>Lucitone FRS</td>
<td>7.67</td>
<td>7.81</td>
<td>7.98</td>
<td>8.02</td>
<td>8.45</td>
<td>8.05</td>
</tr>
</tbody>
</table>
The statistical analysis of hardness for the two denture base materials tested is as following:

<table>
<thead>
<tr>
<th>Material</th>
<th>Mean (M Pa)</th>
<th>± SD</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trevalon</td>
<td>14.62</td>
<td>0.19</td>
<td>42.774</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Lucitone FRS</td>
<td>7.99</td>
<td>0.29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The hardness values ranged from 14.4 VHN to 14.9 VHN for Trevalon and 7.67 VHN to 8.45 VHN for Lucitone FRS (Table1). The highest mean value for hardness was obtained for Trevalon. Statistical analysis test (Table 2) showed that there was significant difference between the hardness among the two denture base materials.

**Discussion**

The denture base is the part of the denture which rests on the soft tissues and does not include the artificial teeth. Artificial dentures should be sufficiently hard in order to serve successfully for a reasonable length of time. Vulcanite was the first materials used for fabrication of denture bases. It was patented by Nelson Goodyear in 1851. The Vulcanite was both hard and flexible. However it had poor esthetics and dimensional stability. In 1930 conventional acrylic resin (PMMA) replaced Vulcanite as the new denture base material. It was strong, dimensionally stable and esthetic. However it was prone to polymerization shrinkage and caused allergic reaction in certain patients due to the presence of residual monomer.

The twenty first century marked the resurrection of the Vulcanite. The Vulcanite was reinforced by nylon, glass-fibers etc. to render it strong and unbreakable. The new product was more esthetic in appearance as well. It possessed more dimensional accuracy as it employed injection molding technique when compared to acrylic resins\(^5\). It had the added advantage of being monomer free\(^5\).

The present day Vulcanites are collectively referred as flexible resins. The flexible resin—Lucitone FRS is chemically nylon based plastic linear polyamide. It has long term performance. Polymer unzipping is negligible and hence it is highly stable. It also
had high creep resistance and fatigue endurance. It had good wear characteristics and solvent resistance. It had no porosity, no biological material build up, odor or stains. It provided good dimensional and colour stability. It needed minimal adjustments. It could be relined and repaired easily.

(a) Hardness is defined as the resistance to permanent surface indentation or penetration. At microscopic level hardness involves complex surface morphologies and stresses in the test material. Hardness is therefore a measure of the resistance to plastic deformation and is measured as force per unit area of indentation. A dental prosthesis should be reasonably hard to resist surface deformation and fracture. In this study Lucitone showed a mean hardness value of 7.99 VHN and Trevalon showed a mean hardness of 14.62 VHN.

(b) Statistical analysis using students ‘t’ test parametric analysis revealed that there is statistically significant difference of (P<0.01) for hardness between Trevalon and Lucitone FRS.

Conclusions

Denture bases are critical component of Prosthodontics. They act as foundation from where denture teeth can be constructed. The present study highlights the hardness of two different denture base materials namely Trevalon and Lucitone FRS. It reveals that out of the two denture base materials, Trevalon is almost twice as hard as Lucitone FRS. Therefore Trevalon is ideal in cases where cross arch stabilization is required, cases which necessitate additional reinforcements, cases of repeated denture fractures and cases where surface area of dental arch is large. On the other hand Lucitone FRS can be successfully used in cases of small arch complete dentures, removable partial dentures, maxillofacial prosthesis with deep undercuts and in cases were patient is allergic to monomer. The information presented in the study will aid the Dentist in selection of ideal denture base materials for specific cases.
References


