Full Length Research Paper

Posterior palatal base distortion of ProBase Hot versus the conventional heat cured acrylic resin before and after water immersion

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Abstract

Objectives; This study was carried out to compare the posterior palatal base distortion of denture bases processed with ProBase Hot to those processed by conventional heat cure acrylic resin (Acrostone) before and after water immersion. Study design; Twenty waxed denture bases were prepared for U-shaped palatine arch form, ten for each denture base material. Wax ed denture bases were flaked, packed and processed according to the manufacturer’s instructions. Immediately after decasting, the dentures were repositioned on their corresponding casts to measure the amount of gap formed between denture base and cast at 5 points along the posterior border of denture base using a measure scope. Denture bases were stored in tap water for 4 weeks then the same test was repeated. Results; This study demonstrated a posterior palatal base discrepancy for both materials particularly at the center of the palate. ProBase Hot showed better results than that of the conventional acrylic resin. Regarding water sorption, all the tested groups showed significant posterior palatal base accuracy when stored in tap water for 4 weeks. Conclusions; ProBase Hot is a better choice for constructing denture bases to compensate for the increased distortion due to palatal shape.

Keywords: Dimensional accuracy, Discrepancy, Adaptation, Acrylic resin, ProBase Hot

INTRODUCTION

The major objective for construction of complete dentures is to obtain a denture base that conform the supporting tissues to a high degree of accuracy. It is believed by many authors that intimate tissue contact and peripheral seal of the denture base comprise the most critical retentive factors. Unfortunately, all available resins used in dentistry undergo shrinkage during processing. Poor fit of denture was evident as a result of shrinkage of denture base (Chandu et al., 2014).

The posterior border of the denture base shows the greatest amount of processing shrinkage. The greater the curvature of the tissue at the posterior palatal region, the greater its distortion. Studies revealed non-uniform discrepancy pattern between the denture base and cast. The greater discrepancy occurred at the midpalatal region of the posterior border in the area of posterior palatal seal. Discrepancies in this area will most certainly have a negative effect on the retention of a denture base (Vivek et al., 2013).

On the basis of a large number of studies, a generally satisfactory processing temperature for the heat curing acrylic resin is between 71-77°C regarding its dimensional stability. A satisfactory processing procedure is to cure the material in water bath at 74°C for 8 hours or
longer (long curing cycle). Another satisfactory method is to cure the material in water bath at 74°C for 1.5 hours and then at 100°C for one hour (short curing cycle (Craig, 2006).

Recent advances and modifications of poly-methyl methacrylate had been used for denture base applications, include pour type denture resins, hydrophilic polyacrylates, high impact strength resins, rapid heat polymerized acrylic, and light activated denture base material (Craig, 2006). “ProBase Hot” was introduced as a new denture base material which is supposed to set a high standard of quality for the processing properties, accuracy of fit, and stability of shape than that of heat cured denture base materials (Al Hamd and Dhuru, 2014). Gradual expansion of the acrylic dentures results after storage in water. It is thought that this expansion would partly compensate the processing shrinkage after period of time. Denture plastics of the same type may vary considerably in water sorption because of the presence of additives (Phillips, 2006). There are several methods that are used in the measurement of the adaptation accuracy of upper complete denture like microscopic measurement of the gap space between the denture base and the cast or weighing an elastomeric materials impressed under the denture base.

A little is known about ProBase Hot denture base material, and though, it is valuable to test its properties in an attempt to find a material which produces a denture base with better fitness and retention. The hypothesis of this study was that ProBase Hot material is superior in palatal base accuracy compared to the Acrostone denture base material. This study was conducted to compare the posterior palatal base accuracy of maxillary denture bases with u-shaped palatine arch form constructed from ProBase Hot with those constructed from conventional heat cured acrylic denture resin.

METHODS
One completely edentulous patient had a moderately high U-shaped palatine vault was selected (common arch form). The maxillary residual alveolar ridge was free of any obvious ridge undercuts and covered with firm, dense and healthy mucosa. Primary impression of the maxillary arch was made using irreversible hydrocolloid impression material [CavexCA37, Normal Set. Cavex Holland BV, P.O. BOX 852, 2003 RW Haarlem, The Netherlands]. The impression was rinsed and immediately poured into plaster to obtain a primary cast. Auto-polymerized spaced acrylic resin [Acrostone cold cure denture base material. Acrostone dental factory, Industrial zone, El-Salam city, Egypt] special tray was fabricated and border molded using green stick compound [Green sticks impression compound. Kerr Italian S.r.l., via Passanti332, I-84018 Scafati, Salerno, Italia]. Secondary impression was taken using zinc oxide eugenol impression material [CavexCA37, impression paste. Cavex Holland BV, P.O. BOX 852, 2003 RW Haarlem, The Netherlands], exerting slight pressure to the mucosa. It was rinsed, boxed and poured in extra-hard dental stone [Kopo-Rock CKR-35, super dental rock. Kopo-Dental, ISI-KUANG PANG]. Master cast was produced for the U-shaped palatine form.

The master cast was beveled along its posterior edge to allow a better view of the posterior palatal area during gap measurements. Five reference marks were prepared by making deep scratches on the posterior wall of each maxillary master cast, using a sharp scalpel. These points were (Figure 1):

**Point a:** at the left ridge crest.
**Point b:** at the right ridge crest.
**Point c:** at the midline of the palate.
**Point d:** at the left buccal area.
**Point e:** at the right buccal area.

Each master cast was duplicated into twenty stone casts using duplicating reversible hydrocolloid [Technojet reversible duplicating material. Protechno, E-17469 Vilamalla (Girona), Spain]. The maxillary master cast was first soaked in water for 15 minutes and then fixed to the...
base of aluminum duplicating flask by sticky wax. The base of the flask was sealed with sticky wax and the molten reversible hydrocolloid was poured from an opening on the top cover of the flask. After complete hardening of the duplicating material, the base of the duplicating flask was opened and maxillary cast was removed. The mold cavity was poured in dental stone.

To obtain standardized maxillary denture bases, the waxed denture base was duplicated using the putty form of silicone elastomeric impression material [Alphasil Perfect. Muller-Omicron GmbH and Co. KG, D-51789 Linder, Germany]. The impression was done for the upper denture base together with its cast, using a large stock tray contoured with base-plate wax. The impression material was sufficient to cover the entire polished surface of the waxed denture base to or beyond the height of the cast inside the tray. The excess material was trimmed to be flushed with the borders of the base of the cast. After setting of the material, the waxed denture base together with its cast was removed, leaving a mold within the impression material. Two escaping holes were prepared at the rear wall of the rubber base impression mold (Figure 2).

One of the intact duplicate casts was seated in the mold carefully, in its position outlined during denture base duplication. The cast and the tray containing the mold were tightened together using a rubber band. Molten base-plate wax [CavexSetUp Regular Modelling wax. Cavex Holland BV. P.O. Box 832, 2003 RW Haarlem, The Netherlands] was poured in the mold cavity from one of the two holes previously prepared at the rear of the impression mold. The other hole was used for the escape of air and excess molten wax. After wax was cooled, the cast, together with the formed wax denture base, was removed from the impression mold. The previous procedure was repeated for all the duplicate casts. Twenty standardized denture waxed bases were obtained.

Flasking was done using standardized stone-plaster mix, and then all flasks were pressed under the hydraulic press using the same pressure. The waxed denture bases were washed out of wax after setting of the stone-plaster mix. Ten out of the twenty waxed denture bases were processed into conventional heat cured acrylic denture bases [Acrostone Heat cure denture base material. Acrostone Dental factories, Industrial zone, EL-Salam city, Egypt.], while the other ten waxed denture bases were processed into ProBase Hot denture bases [ProBase Hot® Heat cure denture base material. Ivoclar Vivadent AG. Bendererstrasse 2. 9494 schaan/Liechtenstein]. According to the manufacturer's directions for both tested denture base materials; ProBase Hot and conventional heat cured acrylic resin, a standard mix of each was packed into its subsequent mold and pressed using the same pressure used before. For ProBase Hot Ideal mixing ratio for one denture was 22.5 g polymer (powder): 10ml monomer (liquid). The integrated dosage system ensures an ideal mixing ratio and, therefore, minimum polymerization shrinkage of ProBase Hot. The conventional heat cured denture bases were cured in water bath at 74 °C for 1.5 hours and then for 100 °C for 1 hour (short curing cycle). Probase Hot denture bases were placed in cold water bath and heated up to 100 °C and let boil for 45 minutes. After curing, the flasks were left to cool and reach the room temperature before deflasking.

The posterior palatal gap was measured using a two dimensional measurescope [Nikon, Japan] with a measuring accuracy of 0.001 mm. Acquisition of data was done directly by a computer connected to the measure scope. The first measurements were done at the five reference points after removing the denture bases out of their casts and repositioning them again (Figure 3). The denture bases were stored in water at room temperature for 4 weeks, after which the measurements were repeated. To aid in viewing the top end of the scratches on the cast referring to the points to be measured, graphite marks were scribed on the end.
points to aid in focusing on them. The measurement was repeated 3 times to determine the mean value for each reference point.

Statistical analysis

The calculated values for the recorded data were statistically analyzed by using Paired t-test.

RESULTS

Mean values of denture base distortion for maxillary ProBase Hot and Acrostone at points (a, b), measured immediately after decasting and after 4 weeks of water immersion are presented in Tables 1 and 4. There was no significant difference between both denture bases at these points of measurements immediately after decasting or after 4 weeks of water immersion.

Mean values of denture base distortion for maxillary ProBase Hot and Acrostone at point (c), measured immediately after decasting and after 4 weeks of water immersion are presented in Tables 2 and 5. There was a significant difference between both denture bases at this point of measurements immediately after decasting or after 4 weeks of water immersion.

Mean values of denture base distortion for maxillary ProBase Hot and Acrostone at points (d,e), measured immediately after decasting and after 4 weeks of water immersion are presented in Tables 3 and 6. There was no significant difference between both denture bases at
Table 3. Mean values of posterior palatal base discrepancy in mm for maxillary ProBase Hot and Acrostone at points (d,e), measured immediately after decasting.

<table>
<thead>
<tr>
<th>ProBase Hot</th>
<th>Conventional acrylic (Acrostone)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>P ≥ 0.05</td>
</tr>
<tr>
<td>0.173 ± 0.06</td>
<td>0.146 ± 0.02</td>
<td>P ≥ 0.05</td>
</tr>
</tbody>
</table>

P ≥ 0.05 no significant difference
SD: Standard deviation

Table 4. Mean values of posterior palatal base discrepancy in mm for maxillary ProBase Hot and Acrostone at points (a, b), measured after immersion in tap water for 4 weeks.

<table>
<thead>
<tr>
<th>ProBase Hot</th>
<th>Conventional acrylic (Acrostone)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>P ≥ 0.05</td>
</tr>
<tr>
<td>0.053 ± 0.014</td>
<td>0.069 ± 0.026</td>
<td>P ≥ 0.05</td>
</tr>
</tbody>
</table>

P ≥ 0.05 no significant difference
SD: Standard deviation

Table 5. Mean values of posterior palatal base discrepancy in mm for maxillary ProBase Hot and Acrostone at point (c), measured after immersion in tap water for 4 weeks.

<table>
<thead>
<tr>
<th>ProBase Hot</th>
<th>Conventional acrylic (Acrostone)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>P ≤ 0.05</td>
</tr>
<tr>
<td>0.340 ± 0.075</td>
<td>0.526 ± 0.084</td>
<td>P ≤ 0.05</td>
</tr>
</tbody>
</table>

P ≤ 0.05 significant difference
SD: Standard deviation

Table 6. Mean values of posterior palatal base discrepancy in mm for maxillary ProBase Hot and Acrostone at points (d,e), measured after immersion in tap water for 4 weeks.

<table>
<thead>
<tr>
<th>ProBase Hot</th>
<th>Conventional acrylic (Acrostone)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>P ≤ 0.05</td>
</tr>
<tr>
<td>0.119 ± 0.052</td>
<td>0.160 ± 0.037</td>
<td>P ≤ 0.05</td>
</tr>
</tbody>
</table>

P ≤ 0.05 significant difference
SD: Standard deviation

Table 7. Mean values of posterior palatal base discrepancy in mm for Acrostone at all points of measurements before and after immersion in tap water for 4 weeks.

<table>
<thead>
<tr>
<th>Points</th>
<th>Time</th>
<th>Mean ± SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a + b)</td>
<td>After decasting</td>
<td>0.115 ± 0.044</td>
<td>P ≤ 0.01</td>
</tr>
<tr>
<td></td>
<td>After water immersion</td>
<td>0.085 ± 0.037</td>
<td></td>
</tr>
<tr>
<td>(d + e)</td>
<td>After decasting</td>
<td>0.150 ± 0.028</td>
<td>P ≤ 0.05</td>
</tr>
<tr>
<td></td>
<td>After water immersion</td>
<td>0.135 ± 0.021</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>After decasting</td>
<td>0.623 ± 0.095</td>
<td>P ≤ 0.05</td>
</tr>
<tr>
<td></td>
<td>After water immersion</td>
<td>0.577 ± 0.094</td>
<td></td>
</tr>
</tbody>
</table>

P ≤ 0.01 & 0.05 significant differences
SD: Standard deviation

these points of measurements immediately after decasting (Table 3) while there was a significant difference after 4 weeks of water immersion (Table 6). Mean value of discrepancy in mm for Acrostone denture base at all points of measurements before and after immersion in tap water for 4 weeks are presented in Table 7. There were significant differences before and after 4 weeks of water immersion at all points of
measurements. Mean value of discrepancy in mm for ProBase Hot denture base at all points of measurements before and after immersion in tap water for 4 weeks are presented in Table 8. There were significant differences before and after 4 weeks of water immersion at all points of measurements. The posterior palatal base discrepancy for both materials were significantly improved after water storage for 4 weeks.

**DISCUSSION**

The dimensional stability of the denture during processing and in service is important in the fit of the denture and the satisfaction of the patient (Craig, 2006). All available resins used in dentistry undergo shrinkage during processing (Thompson et al., 1979). The dimensional changes of the denture base result from both polymerization shrinkage and stresses released during flask cooling (Consani et al., 2002; Anusavice, 2003). The magnitude of the acrylic resin dimensional changes, however, may be influenced by several factors, such as polymerization techniques, where the internal stresses are produced by different coefficients of thermal expansion of gypsum and acrylic resin (Wolfardt et al., 1986), and the base thickness may vary at different sites inside the flask (Chen et al., 1988) altering the denture base adaptation and stability (Jackson et al., 1989). Consequently, the combination of polymerization shrinkage and strain release decreases the adaptation level of denture base to the supporting tissue, influencing the denture base stability (Takamata et al., 1989).

Processing shrinkage of maxillary acrylic denture bases is particularly noticeable in the posterior palatal border region, where the retentive seal and stability of the prostheses can become compromised (Jacobson and Krol, 1983; Sykora and Sutow, 1979). Although the dental position modified by linear changes may be easily corrected by occlusal adjustment, the palatal posterior region, considered to be a critical area in relation to base retention, will be hardly corrected after processing. The processing shrinkage which occurs during polymerization is not uniform and being more evident in the posterior palatal region whilst the dimensional distortion occurs during cooling or after the base is separated from the cast (Chen et al., 1988).

Gradual expansion of the acrylic dentures results after storage in water. It is thought that this expansion would partly compensate the processing shrinkage after period of time (Latta et al., 1990). Denture plastics of the same type may vary considerably in water sorption because of the presence of additives (Craig, 2006). The denture bases were stored in water at room temperature for 4 weeks; as the major portion of the expansion in water takes place during the first month, and the changes are insignificant after 2 months (Phillips, 2006). Although all tested denture bases revealed expansion with no significant difference between groups, ProBase Hot showed the best results towards adaptation. This could be explained by the fact that denture plastic of the same type may vary considerably in water sorption because of the presence of additives (Craig, 2006).

It would be desirable to verify the effect of commercial heat cured acrylic resins on denture base adaptation and clinical fitness. This study was done to verify the dimensional changes of denture bases processed with ProBase Hot which is a commercial heat cured acrylic resin supposed to give high standards of accuracy and fitness (Heqde and Patil, 2004; Kang et al., 2002) and to compare the results with those of conventionally used heat cured acrylic resin (Acrostone) cured using short curing cycle for U-maxillary palatal vault shape. To verify the aim of this study, the selected patients to participate had maxillary edentulous arches free from any obvious undercuts to facilitate decasting of the denture after processing and avoid denture distortion during its removal. Severe undercuts increase denture retention which may affect the dislodging force, and the relief of exaggerated tissue undercuts will deteriorate denture peripheral seal and decrease retention (Ivoclar, 2005).

This study was restricted to the maxillary edentulous arch because locations of the seal areas responsible for retention are constant and don’t move during the ordinary functions of the mouth, unlike the mandibular arch (Winkler, 1988). For secondary impression of maxillary vaults, the special trays were constructed with stops on spacers to minimize and standardize the impression pressure. Zinc oxide eugenol impression pastes were

<table>
<thead>
<tr>
<th>Points</th>
<th>Time</th>
<th>Mean ± SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a + b)</td>
<td>After decasting</td>
<td>0.091 ± 0.048</td>
<td>P ≤ 0.05</td>
</tr>
<tr>
<td></td>
<td>After water immersion</td>
<td>0.068 ± 0.031</td>
<td>P ≤ 0.001</td>
</tr>
<tr>
<td>(d + e)</td>
<td>After decasting</td>
<td>0.147 ± 0.046</td>
<td>P ≤ 0.001</td>
</tr>
<tr>
<td></td>
<td>After water immersion</td>
<td>0.115 ± 0.036</td>
<td>P ≤ 0.001</td>
</tr>
<tr>
<td>(c)</td>
<td>After decasting</td>
<td>0.461 ± 0.090</td>
<td>P ≤ 0.01</td>
</tr>
<tr>
<td></td>
<td>After water immersion</td>
<td>0.417 ± 0.103</td>
<td>P ≤ 0.01</td>
</tr>
</tbody>
</table>

P ≤ 0.01 & 0.05 significant differences
SD: Standard deviation

Table 8. Mean values of posterior palatal base discrepancy in mm for ProBase Hot at all points of measurements before and after immersion in tap water for 4 weeks.
used as they produce a rigid impression with a high degree of accuracy, good reproduction of surface details and are quite stable dimensionally. Pressure areas can easily be detected in a zinc oxide impression (Craig, 2006). Zinc oxide eugenol impression material doesn’t absorb palatal mucous secretions which produce defects in the palatal part of the impression and it doesn’t require a separating medium which may affect the denture retention (Wright, 2004).

The denture bases were tested for accuracy immediately after decasting since the distortion upon removal of the denture from the cast was greater than any other subsequent changes, due to strain relaxation (Phillips, 2006). Points of measurement were decided to be along the posterior border of the denture base; since studies showed that accuracy was better from the anterior to the middle of the palate and become worse toward the posterior of the denture (Phillips, 2006; Consani, 2002). Graphite marks were scribed on the upper end points of the reference marks on the casts to allow easy focusing of the lens of measure scope. A plaster index was made for proper base fixation and orientation during accuracy measurements.

Regarding accuracy measurements, ProBase Hot denture bases showed a highly significant decrease in gap formation compared to Acrostone denture bases at point (c) representing midpalatal point along the posterior borders of denture bases. ProBase Hot denture bases also showed the least mean values for gap formation regarding the other points of measurements, when measured after decasting. ProBase Hot material showed the least distortion when compared to other commercial products (Kang and Kim, 2002). This may be attributed to the difference in cross-linking agent between different commercial products (Zarb and Bolender, 2004), as ProBase Hot rely on high levels of crosslink resin and heat activated initiators to maximize the physical properties of the processed materials (Arima et al., 1996). For all the tested denture bases, the greatest amount of discrepancy was found in the center of the palate, and then decreased toward the crest of ridge. The possible explanation to this phenomenon may be due to the shrinkage of the resin toward the areas of the greatest bulk, which is the ridge portions of the denture base, such shrinkage causes a tensile stresses to occur in the thinner palatal region, when these stresses are relieved, the resin pulled away from the palate (Phoenix, 1996).

Also this study revealed that the distortion at buccal areas was greater than that at the ridge crests. The magnitude of the acrylic resin dimensional changes may be influenced by the base thickness which may vary at different sites between marginal and central zones inside the flask. Also, a region which is flatter, less restrictive and permits strain release, could produce more evident distortion (Hamouda et al., 1992). This may explain the greater magnitude of distortion at buccal areas.

CONCLUSIONS

From the results of this study it was concluded that:

1. ProBase Hot denture bases showed better dimensional accuracy than conventionally used acrylic denture bases.
2. ProBase Hot is a better choice for constructing denture bases to compensate for the increased distortion due to palatal shape.
3. All the tested groups demonstrated improved dimensional accuracy when stored in tap water for 4 weeks.

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REFERENCES


