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Influence of Storage Period and Effect of Different Brands of Acrylic Resin on the Dimensional Accuracy of the Maxillary Denture Base

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The aim of this study was to evaluate the dimensional changes of denture bases made from different resins after different storage periods. For this purpose, 25 sets of plaster models/resin bases were prepared using 4 acrylic resins submitted to two types of polymerization: 1- QC-20 submitted to polymerization by microwave energy; 2- QC-20 submitted to polymerization by water hot bath; 3- Vipi Cril submitted to polymerization by water hot bath; 4- Vipi Wave submitted to polymerization by microwave energy; and 5- Onda Cryl submitted to polymerization by microwave energy. After polymerization, the specimens were sectioned for accuracy readings using a comparison microscope. Readings were taken at 3 points: the crests of the right (A) and left (B) ridges, and the median region of the palate, in 4 different periods. The data obtained were submitted to two-way ANOVA and Tukey's test at 5% significance level. The greatest distortions were found in the posterior palatal region of the base (M), with statistically significant difference ($p<0.05$) for the studied resins. All acrylic resins presented dimensional changes and the storage period influenced these alterations.

Key Words: dimensional change, denture base, packing methods, post-pressing time.

INTRODUCTION

The magnitude of the acrylic resin dimensional changes may be influenced by several factors, such as polymerization techniques, in which the internal stresses are produced by different coefficients of thermal expansion of gypsum and acrylic resin (1), and the base thickness, which may vary at different sites inside the flask (2,3), altering the denture base adaptation and stability (4).

Dimensional changes in denture bases result from monomer shrinkage during polymerization and stresses released when the flask cools. Shrinkage due to the polymerization reaction is not uniform, being more accentuated in the posterior region of the palate, and it is difficult to compensate after processing. Conversely, distortion results from cooling and removal of the base from the plaster model, both causing the release of stresses induced during processing (5).

Although acrylic resin is the most commonly used material in artificial dental construction, it is subject to polymerization shrinkage and distortion. The shrinkage resulting from the polymerization reaction is not uniform, being more evident on the palate of the maxillary denture and is be poorly compensated after resin base processing (3). Conversely, the distortion resulting from flask cooling and stone cast deflasking induces stresses released during the base procedure (6).

The stress released later, gain or loss of water and incomplete denture polymerization are factors responsible for the dimensional changes occurring after removal of the denture from the stone cast and the most

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likely causes for denture inaccuracy (7).

The aim of this study was to verify the dimensional accuracy of denture bases made from different resins after different storage periods. The hypothesis of this study should be that different commercial types of acrylic resin and different periods of storage can change the adaptation of the denture base.

MATERIAL AND METHODS

Five specimens were made for each studiedresin: QC-20 microwave cure (Dentsply International Inc., York, PA, USA), QC-20 conventional cure (Dentsply), Vip Cril conventional cure (Dental Vipi Ltda, São Paulo, SP, Brazil), Vipi Wave microwave cured (Dental Vipi Ltda), and Onda Cryl microwave cured (Clássico Artigos Odontológicos Ltda, São Paulo, SP, Brazil).

In order to make the specimens, 25 edentulous maxillary models were poured with type 3 stone plaster from a RTV 3120 silicone mold. The silicone mold was obtained from a maxillary arch without imperfections or irregularities at the crest on the alveolar ridge.

Two-millimeter-thick wax record bases were made on respective stone cast (8) with aid of a specimen meter (Wilcos Stainless, Toronto, Canada). After wax adaptation on the stone cast, the excess was trimmed and the peripheral limit oriented until sealing of the zones corresponding to the vestibular flanges was obtained. The models with wax bases were included in metallic or plastic flasks in accordance with laboratory routine procedures.

The acrylic resins were used according to the manufacturer's instructions, and packed in the plastic phase into the flasks under a final pressure of 1,200 kgf. The flasks were carried out in traditional strain clamps, and the resins were submitted to the polymerization cycles according to the protocol: 1- QC-20 polymerized by microwaves at 840 W for 3 min; 2- QC-20 submitted to water bath at 100°C for 20 min; 3- Vipi Cril submitted to water bath at 70°C for 30 min + 60 min at 100°C; 4- Vipi Wave submitted to microwaving at 800 W power, being 20 min at 10/20% of the power + 5 min at 50/60% of the power; and 5- Onda Cryl submitted to microwaving at 800 W power, being 3 min at 40%, 4 min at 0% and 3 min at 90% of the power.

After cooling to room temperature, the flasks were opened and the resin excesses trimmed from the edge of the resin base. The base/cast sets were sectioned transversally in the posterior palatal zone, using a manual saw under constant water cooling to prevent acrylic resin changes. On each section, 3 referential points were demarcated: median region (M), crest on the right (A) and left (B) ridge (Fig. 1). For better visualization of dimensional accuracy of the base to the plaster model, the sectioned surface was gently smoothed with abrasive papers (3M, Nova Odessa, SP, Brazil) in order to regularize the surface and facilitate the base/cast gap measurements. The records were taken using an optical linear microscope (Mitutoyo, Mfg. Co, Tokyo, Japan) with an accuracy of 0.0001 mm.

Four readings were taken: 1: immediately after model/base sectioning; 2: after model/base sectioning, and immersion in distilled water at 35 ± 2°C for 90 days; 3: immediately after resin base removal, which was finished with abrasive paper and fixed to the respective casts with instantaneous adhesive; 4: after immersion in distilled water at 35 ± 2°C for 180 days.

The data obtained were submitted to two-way ANOVA and Tukey's test at a 5% level of significance.

RESULTS

At the crest of the right ridge (A), in the period of 90 days, statistically significant difference (p=0.01314) was found among the materials Vipi Cril, Vipi Wave, QC-20 conventional and microwave cure (Table 1). At the crest of the left ridge (B), there was no statistically significant difference (p>0.05) among the studied materials (Table 2).

For the cuts in regions A and B, the 180 days reading showed the largest dimensional changes among the resins. (Tables 1 and 2). In the posterior region (M),

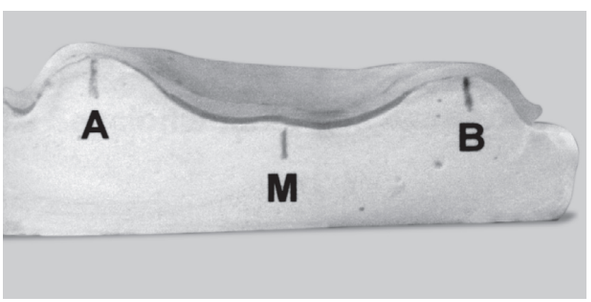

Figure 1. Referential points in the transverse sections used to determine the dimensional changes in the cast/resin set. Median region (M) and crest on the right (A) and left (B) ridges.

there was statistically significant difference (p=0.01415), as observed in the resin base removal. On the median region (M), statistically significant difference (p=0.02943) was found in the values for all materials, except for the immersion for 90 days (Table 3).

The values (mm) for the regions presented statistically significant difference (p=0.0213) for all cuts, with the region M showing the largest discrepancy (0.3109 ± 0.055), followed by region A (0.0756 ± 0.022) and region B (0.0259 ± 0.019).

Table 1. Mean dimensional change values (mm) at the crest of the right ridge (A).

Material	1st Reading (Immediate)	2nd Reading (90 days)	3rd Reading (90 days)	4th Reading (180 days)
QC-20 Microwave	0.01 ± 0 Aa	0.01 ± 0 Aa	0.039 ± 0.016 Bab	0.064 ± 0.026 Bb
QC-20 Conventional	0.01 ± 0 Aa	0.01 ± 0 Aa	0.049 ± 0.020 Bab	0.070 ± 0.030 Bb
Vipi Wave	0.01 ± 0 Aa	0.01 ± 0 Aa	0.070 ± 0.024 Bb	0.099 ± 0.030 ABb
Onda Cryl	0.01 ± 0 Aa	0.01 ± 0 Aa	0.104 ± 0.007 ABb	0.134 ± 0.010 ABb
Vipi Cril	0.01 ± 0 Aa	0.01 ± 0 Aa	0.124 ± 0.013 Ab	0.183 ± 0.017 Ab

Different uppercase letters indicate statistically significant difference at 5% level in lines (groups); Different lowercase letters indicate statistically significant difference at 5% level in columns (readings).

Table 2. Mean dimensional change values (mm) at the crest of the left ridge (B).

Material	1st Reading (Immediate)	2nd Reading (90 days)	3rd Reading (90 days)	4th Reading (180 days)
QC-20 Microwave	0.01 ± 0 Aa	0.01 ± 0 Aa	0.029 ± 0.017 Aa	0.043 ± 0.026 Aa
QC-20 Conventional	0.01 ± 0 Aa	0.01 ± 0 Aa	0.029 ± 0.017 Aab	0.070 ± 0.028 Ab
Vipi Wave	0.01 ± 0 Aa	0.01 ± 0 Aa	0.036 ± 0.022 Aab	0.072 ± 0.030 Ab
Onda Cryl	0.01 ± 0 Aa	0.01 ± 0 Aa	0.048 ± 0.019 Aa	0.062 ± 0.025 Aa
Vipi Cril	0.01 ± 0 Aa	0.01 ± 0 Aa	0.057 ± 0.024 Aab	0.072 ± 0.031 Ab

Different uppercase letters indicate statistically significant difference at 5% level in lines (groups); Different lowercase letters indicate statistically significant difference at 5% level in columns (readings).

Table 3. Mean dimensional change values (mm) in the median region of the palate (M).

Material	1st Reading (Immediate)	2nd Reading (90 days)	3rd Reading (90 days)	4th Reading (180 days)
QC-20 Microwave	0.074 ± 0.013 Aa	0.120 ± 0.018 Aa	0.257 ± 0.021 Ab	0.328 ± 0.016 Ab
QC-20 Conventional	0.080 ± 0.015 Aa	0.145 ± 0.031 Aa	0.334 ± 0.052 Ab	0.440 ± 0.045 Ab
Vipi Wave	0.149 ± 0.023 ABa	0.207 ± 0.029 Aa	0.378 ± 0.047 Ab	0.462 ± 0.049 Ab
Onda Cryl	0.232 ± 0.055 Ba	0.309 ± 0.039 Aa	0.367 ± 0.034 Aab	0.470 ± 0.033 Ab
Vipi Cril	0.162 ± 0.031 ABa	0.397 ± 0.081 Aa	0.601 ± 0.045 Bbc	0.706 ± 0.076 Bc

Different uppercase letters indicate statistically significant difference at 5% level in lines (groups); Different lowercase letters indicate statistically significant difference at 5% level in columns (readings).

DISCUSSION

The hypothesis of this study that different commercial types of acrylic resin and different periods of water storage can change the adaptation of the denture base was confirmed. In this *in vitro* study, the dimensional changes between resin base and the stone cast were assessed using four acrylic resins for denture bases. Measurements were made before and after 6 months of storage in distilled water, at three different points: the crests of the right (A) and left (B) ridges, and the median region of the palate (M). The results of this investigation are in agreement with those of previous studies (3,5,8-16). The greatest dimensional change (0.3109 mm) between the resin base and the plaster cast occurred in the median region of the palate (M).

The smallest dimensional discrepancies were found in the regions corresponding to the crests of the alveolar ridges (regions A and B) immediately after resin base removal (Table 1) and these results were significantly smaller than the values found in the median region of the palate. According to Nishii (9) and Rizzatti-Barbosa (10) this fact could induce an increase in vertical dimension or changes in occlusal tilt of the artificial teeth. Moreover, the A and B regions presented lower values of misfit probably due to the anatomy of these regions, which present greater lateral extension of alveolar bone (11).

Chen et al. (3) affirmed that most dimensional changes that affect the position of the teeth are not clinically significant, and, these changes can be easily corrected by occlusal adjustments. However, according to these authors, dimensional changes in the posterior region of the palate are critical, as this is a very important area for denture retention. It is very difficult to correct small dimensional changes in this region after processing, which could induce clinical implications with a negative effect on denture base retention.

Dimensional changes in bases in the median regions of the palate and the alveolar ridges appear to be related to a supposed lateral-lateral denture base distortion. However, it is possible that this dimensional change is related to other factors, such as the processing method alone. According to Anusavice (12), several variables are involved in the final result of the finished denture. Takamata et al. (13) reported that the different thermal expansion coefficients of resin and plaster during flask cooling may increase resin shrinkage, due to the internal stresses developed. The release of stresses induced after separating the base-model causes distortions in the resin and increases the inaccuracy of the denture base to support tissues (14). After separation of the bases, a greater and statistically significant dimensional change was found, but not with regard to immersion in distilled water for 180 days, for all commercial brands of resins (Table 1).

Regarding the storage period, there was an increased dimensional change in resin denture base to plaster cast, mainly in the median region of the palate, after 180 days of water storage, which is in agreement with the results of Chen et al. (3), who found an increase in dimensional change in the posterior area of the palate for most dentures analyzed after 30 days of water storage. Nevertheless, some authors affirm that storage in water produces expansion due to the water sorption property of acrylic resins, partially compensating polymerization shrinkage, and consequently, improving the adaptation of the bases. Whereas in the studies of Goodkind and Schulte (15) immersion in water did not produce significant dimensional changes in resin denture bases. An study developed by Consani et al. (16) showed that the water storage for a period of 90 days did not promote significant dimensional changes in the teeth distances when compared to the deflasking period. The results found in this study (Tables 1-3) must be related to the long period of immersion in water (180 days), which resulted in increased dimensional changes with expansion of denture bases, causing major disadaptation (17).

With regard to the factor resin and its respective polymerization cycles, generally speaking, it was found that the polymerization by microwave energy produced less dimensional changes in resin denture bases for the three regions analyzed, independently of the resin (Tables 1-3). The pattern observed is in agreement with the results of Al-Hanbali (13), who reported that resin denture bases polymerized by microwave energy presented better adaptation than those polymerized by the conventional water bath method.

Earlear (18) showed that oral tissues present notable properties of resilience, which does not mean that they remain healthy and normal under conditions of dimensional changes in acrylic resin gretaer than 1 mm. A dimensional change equal to or greater than 0.9 mm causes an inaccuracy in denture stability due the poor base adaptation to the support tissues of the oral

fibromucosa, making impossible its clinically use (19).

The results of the present study are relevant to confirm the complexity of the denture base distortion. Further investigations are necessary to investigate denture processing methods that can obtain minimal denture base inaccuracy, mainly in the posterior palatal region.

Within the limitation of this study, it may be concluded that: 1. Dimensional change of the denture base to the stone cast was influenced by the storage period. The highest means of innacuracy were found in the median region of the palate (M) for all groups analyzed; 2. All resin bases presented dimensional changes. The acrylic resin QC-20 polymerized by the conventional method presented the greatest change in denture base in the median region of the palate.

RESUMO

O objetivo deste estudo foi avaliar a alteração dimensional de bases de prótese total confeccionadas com diferentes resinas após diferentes períodos de armazenagem. Para isso foram confeccionados 25 conjuntos modelo de gesso/base de resina, utilizando-se quatro resinas acrílicas: QC-20 submetida à polimerização convencional e por energia de microondas, Vip Cril submetida à polimerização convencional, Vip Wave e Onda Cryl submetida à polimerização por energia de microondas. Após a polimerização, as amostras foram seccionadas para realização de leituras de adaptação com auxílio de um microscópio comparador. As leituras foram realizadas em três pontos: crista do rebordo direito (A) e esquerdo (B), e região mediana do palato, em quatro diferentes períodos. Os resultados foram submetidos à análise de variância e ao teste de Tukey com nível de significância de 5%. A pior adaptação foi verificada na região palatina posterior da base (M) com diferença estatisticamente significante ($p<0,05$) para as resinas estudadas. Todas as bases de resinas apresentaram alteração dimensional e o período de armazenagem foi um fator que influenciou essa alteração.

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