

Effect of bench-delay after flask cooling on the posterior teeth movement in maxillary complete dentures

Efeito da espera em bancada após o esfriamento da mufla na movimentação de dentes posteriores em prótese total superior

Rafael Leonardo Xediek CONSANI

Assistant Lecturer of Prosthodontics, Dental School of Piracicaba, UNICAMP

Saide Sarckis DOMITTI

Professor, Department of Prosthodontics, Dental School of Piracicaba, UNICAMP

Simonides CONSANI

Professor, Department of Restorative Dentistry, Dental School of Piracicaba, UNICAMP

Mauricio TANJI

Post graduate student, Department of Prosthodontics, Dental School of Piracicaba, UNICAMP

RESUMO

Este estudo avaliou a movimentação de dentes posteriores em prótese total, sob influência da armazenagem em água à temperatura de 37°C, após esfriamento da mufla em água de polimerização e armazenagem em bancada por 3 horas. Foram feitas dez próteses totais superiores com resina acrílica termopolimerizável Clássico pelo método convencional de prensagem em muflas metálicas. Pontos referenciais metálicos foram colocados nos dentes pré-molares (PM) e molares (M). Doze horas após a prensagem final, a resina acrílica foi polimerizada em água aquecida a 74°C por 9 horas. As muflas foram removidas da polimerizadora após esfriamento da água de polimerização e deixadas em bancada por 3 horas. Após esse período, as próteses foram desincluídas, acabadas e armazenadas em água à temperatura de 37°C pelos períodos de uma semana, um mês e três meses. A movimentação dos dentes foi verificada nas distâncias PM-PM, M-M, PME-ME e PMD-MD nos períodos após demulação e armazenagem em água, com microscópio comparador Olympus com precisão de 0,0005mm. Os resultados foram submetidos à análise de variância e ao teste de Tukey (5%). Os autores concluíram que não houve diferença estatística significativa nos valores da movimentação dental em todas as distâncias após armazenagem em água, sob influência da espera em bancada após esfriamento da mufla em água de polimerização.

UNITERMOS

Prótese total; água; movimento dos dentes.

INTRODUCTION

A classic article shows that the subsequent expansion seen after acrylic resin water storage is commonly greater than the shrinkage occurring during the polymerization¹⁶. Due to this unavoidable base polymerization shrinkage, a certain lack of dimensional accuracy has been accepted as one of the disadvantages for the construction of complete dentures, which is partially compensated by water imbibition¹³.

The undesirable distortion of denture bases in clinical use is due to dimensional changes of the acrylic resin¹⁴, and the causes include sorption or

loss of water in the resin base, release of stresses, and flexure fatigue of the base¹⁹.

According to the diffusion theory for assessing the quantitative aspects of the kinetics of water sorption, the diffusion coefficient governs the rate of water sorption and the time required to reach equilibrium, which is also proportional to the specimen thickness¹¹. The denture fits better after water sorption than immediately after processing, considering that the shape of the oral tissues is remained unchanched⁴. Thus, good wetting characteristics of the denture base are important since materials with different surface energies have varying wettabilities²².

The water sorption by dentures in clinical use occurs during the first three months, and the resultant expansion partly compensates the polymerization shrinkage¹⁰, where liquid equilibrium and consequent dimensional stability of the denture base is often attained¹⁵.

A study showed that the dimensional changes of light-cured, heat-cured, and self-cured denture base resins were different from each other after storage for seven days at 37°C in distilled water⁵. However, the linear dimensional changes occurred were similar in all resin brands after storage in water for thirty, sixty and ninety days at 37°C, and these discrepancies were so small that they were not clinically detectable⁶.

Another article stated that the immersion in water at room temperature for 1 hour, one day and one week reduced the base dimensional changes in the continuous-injection technique, whilst no influence was observed for the trial-pack technique, and these dimensional changes were influenced by the palate shape¹⁷.

It has been demonstrated that the water saturation of both dry heat and wet heat-processed dentures is relatively low because of the high initial water content. The linear expansion associated with water sorption does not entirely compensate for the processing shrinkage of dry and wet heat-processed dentures, and do not demonstrate any statistically significant difference in resulting shrinkage²⁰.

The aim of this investigation was to determine the effect of water sorption on the posterior teeth shift in maxillary complete dentures, after storage for one week, one month, and three months at temperature of 37°C, when the flasks were bench stored for 3 hours after cooling in the curing water.

MATERIALS AND METHODS

Ten maxillary complete dentures were made from similar stone casts simulating an arch without irregularities in the alveolar ridge crest. The wax denture base-plates, with thickness of 2mm, were made on the respective casts. The height of the occlusion wax-rims was 20mm in the labial sulcus of the cast, and 10mm in the second molar region. The upper stone casts were mounted in a Mondial 4000 semi-adjustable articulator (Bio-Art Dental Products, São Carlos, SP, Brazil) with the wax-rim interocclusal relation in accordance with

the teeth of a lower stone cast in the following references: intercondilar distance in M, Bennett angle of 15°, and condilar guide of 30°. In order to accurately mount all dentures on the articulator, similar V-shaped notches were carved in the base of the upper casts.

The arrangement of the left anterior teeth was initiated with the carved wax-rim to serve as a guide for the central and lateral incisors, and canine positions. The same procedure was employed in the right arch. The left posterior teeth were arranged starting with the first pre-molar until the second molar. The same procedure was used in the right arch. The teeth arrangement for the interocclusal relationship was anterior vertical overlap and Angle class I for the posterior teeth.

Metallic reference pins were placed in the incisal border of the labial cusp of the first pre-molars, and mesiolabial cusp of the second molars. The dentures were flaked conventionally in Herodent Soli-Rock dental stone (Vigodent, Rio de Janeiro, RJ, Brazil), using a standard metallic flask (J. Safrany Metallurgy Co., São Paulo, Brazil). The waxed dentures were softened for 10 minutes in boiling water. The two halves of the flasks were separated, the wax removed and the stone cleaned with detergent and boiling water. After bench cooling, one coat of Isolak sodium alginate (Clássico Dental Products, São Paulo, SP, Brazil) was used as mold separator.

The heat-cured acrylic resin (Clássico Dental Products), based on the polymethylmethacrylate, was prepared with a polymer : monomer ratio of 3:1 by volume, and the plastic dough was packed in the flasks under a final packing pressure of 1,250 kgf. Twelve hours after the final flask closure, the acrylic resin was polymerized in water bath cycle at 74°C for 9 hours. After polymerizing, the flasks were cooled slowly inside the water bath, removed from the thermo-polymerizing unit (Termotron Dental Products, Piracicaba, SP, Brazil), and bench stored for 3 hours. After this period, the dentures were deflaked, polished, and the PM-PM (pre-molar to pre-molar), M-M (molar to molar), LPM-LM (left pre-molar to left molar) and RPM-RM (right pre-molar to right molar) distances were measured with a STM microscope (Olympus Optical Co., Tokyo, Japan) with an accuracy of 0.0005mm.

After water storage at 37°C for periods of one week, one month, and three months, the PM-PM

(pre-molar to pre-molar), M-M (molar to molar), LPM-LM (left pre-molar to left molar) and RPM-RM (right pre-molar to right molar) distances were measured in the same manner as used following the denture deflasking. Resulting data were submitted to ANOVA and Tukey's test (5%).

RESULTS

No statistically significant difference was observed in the PM-PM, M-M, LPM-LM and RPM-RM distances among deflasking period and water storage periods, when the flask was bench stored after cooling in curing water bath (Table 1).

Table 1 - Means \pm SD of posterior teeth movement for the storage periods, in relation to teeth distance factor

Storage period	Teeth distance (mm)			
	PM-PM	M-M	RPM-RM	LPM-LM
Deflasking	39.70 \pm 0.47 a	52.85 \pm 0.79 a	20.82 \pm 0.74 a	20.13 \pm 0.76 a
7 days	39.70 \pm 0.46 a	52.85 \pm 0.77 a	20.73 \pm 0.74 a	20.05 \pm 0.66 a
30 days	39.64 \pm 0.46 a	52.80 \pm 0.81 a	20.59 \pm 0.88 a	19.88 \pm 0.88 a
90 days	39.72 \pm 0.45 a	52.85 \pm 0.81 a	20.65 \pm 0.92 a	19.94 \pm 0.98 a

Means followed by identical letters in column do not differ statistically (5%).

DISCUSSION

Classic studies have shown that the expansion promoted by water sorption of the heat-cured resin bases compensates, in part, for the shrinkage which occurs during the denture polymerization^{10,13}.

The effect of the water sorption on the teeth movement is difficult to evaluate due to the divergent results showed by several studies. The literature shows that the water sorption by resin base occurs during clinical use and the resulting dimensional changes may affect the occlusion of the denture, and the complex expansion of the bases following the water sorption causes changes in the occlusion due to movement of the teeth¹¹. Although the reduction of the vertical dimension is small, this may cause discomfort to patients¹³.

Based on other studies, it was expected that expansion would occur when the deflasked dentures were stored in water, since the water imbibition by acrylic resin is a well-established occurrence^{10,13}. However, the results from this study showed that water storage promoted values with no statistical significant differences when compared to the deflasking period (Table 1). These results are not consistent with an other study, which showed that the monomer remaining immediately after deflasking

affects the water uptake level⁶. Conversely, our results agree with the same study showing no significant differences in the linear dimension change of acrylic resin specimens stored in water for up to three months⁶. Following storage in water for thirty days, the acrylic resin bases also showed no significant change in dimensional expansion^{1,3}.

Studies showed differences in the total water content at saturation according to the cooling flask method. Thus, similar linear changes were observed in the bench cooled denture bases and in those cooled slowly inside the water bath²⁰. Dimensional changes by water sorption cause expansion apparently due to the entry of water between molecules of the polymethylmethacrylate^{2,4}, resulting in a plasticizing effect¹², when absorbed during polymerization or immersion in water¹⁸. This study suggests that the amount of water uptake by volume of mass was not sufficient to cause posterior teeth movement in all storage periods. Since the initial water content in the wet heat-processed dentures is great²⁰, the subsequent saturation level by water storage decreased. In contrast, a study verified that water immersion for eight weeks compensated, in part, the polymerization shrinkage, and that dimensional changes were influenced according to the different region of the dentures⁷.

The results from this study suggest that the posterior teeth movement is also dependent to some factors occurring during the construction of the denture, such as base thickness¹², geometrical palate shape¹⁷, closure flask pressure⁹, cooling method of the flask²¹, different stresses released in different parts of the denture¹⁹, and mesiodistal teeth contact⁸.

CONCLUSIONS

The results of this study demonstrate that the water storage after flask cooling in curing bath water and bench storage did not cause dimensional changes in the posterior teeth distances when compared to the deflasking period.

ABSTRACT

The aim of this investigation was to verify the influence of bench-delay on posterior teeth shift after denture storage in water at temperature of 37°C, when the flask was cooled in curing water bath. Ten maxillary complete dentures were constructed with Clássico heat-cured acrylic resin using the conventional method of packing in metallic flasks. Metallic reference pins were placed in the labial cusp of the first pre-molars (PM), and mesio-labial cusp of the second molars (M). The acrylic resin was polymerized twelve hours after final flask closure in a water bath cycle at 74°C for 9 hours. The flasks were removed from the thermo-polymerizing unit after water-cooling, and remained stored on the bench for 3 hours. After deflasking and finishing, the dentures were stored in water at temperature of 37°C for periods of one week, one month, and three months. After deflasking and storage period tested, the PM-PM (pre-molar to pre-molar), M-M (molar to molar), LPM-LM (left pre-molar to left molar) and RPM-RM (right pre-molar to right molar) distances were measured with a STM Olympus microscope, with an accuracy of 0.0005mm. Collected data were submitted to ANOVA and Tukey's test (5%). No statistically significant difference was noted in the posterior teeth shift in all distances, when the deflasking period was compared with the periods of water storage.

UNITERMS

Complete denture; water; teeth movement.

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Dr. Rafael Leonardo Xediek Consani
Rua Dr. José Vizioli, 255
13400-450 - Piracicaba, SP
rconsani@merconet.com.br