

Dimensional stability of distances between teeth in complete dentures comparing microwave polymerization and conventional cycles

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Abstract

Aim: This study investigated the tooth movement of complete dentures processed by microwave activation and conventional processing method in water bath. **Methods:** Twenty maxillary complete dentures were fabricated and randomly assigned to 4 groups (n=5): Group I: Classico conventional heat-curing acrylic resin processed by microwave polymerization; Group II: Classico resin processed in water bath at 74°C for 9 h (control-group); Group III: QC-20 fast heat-curing acrylic resin processed in boiling water for 20 min; Group IV: Onda-Cryl microwave acrylic resin processed at the same conditions of Group 1. Metallic referential pins were placed on the incisal border of the central incisors, buccal cusp of the first premolars, and the mesiobuccal cusp of the second molars. Transversal and anteroposterior distances were measured before and after the complete dentures processing with a linear optical microscope (Olympus Optical Co., Tokyo, Japan) accurate to 0.0005 mm. Data were subjected to ANOVA and Tukey's test at 5% significance levels. **Results:** Inside each group, dentures showed some tooth movement but without statistical difference before and after the polymerization. **Conclusions:** Dentures processed by microwave energy presented similar performance to those subjected to conventional cycles in water bath for most of distances evaluated.

Keywords: complete denture, tooth movement, artificial tooth.

Introduction

It is clinically important that dentures have accurate occlusal contacts to guarantee normal function. The evaluation of tooth displacement has been important in seeking a more stable occlusal pattern, retention, and functional quality of complete dentures¹. Studies have shown that typically, the magnitude of dimensional changes is not too large²⁻³, and mean changes of -0.1% to -0.4% have been reported as having no significant influence on the serviceability of dentures⁴.

The performance of different polymerization cycles, including the microwave technique, was analyzed in some investigations considering the processing alterations⁵⁻⁶. After the Nishi's publication in 1968⁷, microwave processing has been appointed as fast⁸, clean⁹ method that promotes an ideal fitting of the denture to the cast¹⁰. The use of conventional heat-curing acrylic resins instead of microwave-activated ones and that influence on the dimensional changes also remain unresolved¹¹⁻¹². Thus, this study evaluated the magnitude of the linear tooth movement in complete dentures submitted to conventional and microwave

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polymerization cycles using different resin types.

Material and methods

A silicone mold (Elite Double; Zhermack, Rovigo, Italy) was obtained from a metal master edentulous maxillary die without irregularities in the alveolar ridge walls. Twenty identical casts were poured from this mold with type III dental stone (Herodent Soli-rock; Vigodent, RJ, Brazil) and the water/powder ratio was 30:100.

A uniform denture base was made with a 2-mm-thick plate wax (Epoxiglass; Epoxiglass Chemical Products, Diadema, SP, Brazil) measured with a caliper. The height of the occlusion wax rim was 20mm in the buccal sulcus of the cast and 10 mm in the second molar area. The maxillary stone cast was mounted in a Mondial 4000 semi-adjustable articulator (Bio-Art Dental Products, São Carlos, SP, Brazil) with the wax rim interocclusal relation according to the mandibular metal cast teeth, with the following references: intercondylar distance in M, Bennett angle at 15 degrees, and condylar guide at 30 degrees.

The arrangement of the left anterior teeth started with the carved wax rim serving as a guide to the positions of the central and lateral incisors and canines. The same procedure was used on the right side. The posterior teeth were arranged starting with the first premolar up to the second molar. The same procedure was used in the right arch. The arrangement of the teeth for the interocclusal relationship was anterior vertical overlap and posterior in Angle class I. After finishing the tooth arrangement of the first denture, a silicone (Zetalabor, Zhermack, Rovigo, Italy) matrix was made fitted to all buccal aspects of the denture, comprising the buccal and incisal surfaces of anterior teeth and buccal and occlusal surfaces of posterior teeth. The purpose of this matrix was to guide the standardized arrangement of the teeth in all the samples.

Metallic reference pins (Cadena, Coats Textil Ltda., SP, Brazil) were placed with cianoacrylate adhesive (Super Bonder; Loctite, São Paulo, SP, Brazil) at the incisal border of the central incisors, buccal cusp of the first premolars, and mesiobuccal cusp of the second molars to serve as reference to quantify tooth movement (Figure 1). Therefore, the following linear distances were considered: RPM-LPM (right premolar to left premolar), RM-LM (right molar to left molar), RI-RM (right incisor to right molar) and LI-LM (left incisor to left molar). The distances were measured with a STM microscope (Olympus Optical Co., Tokyo, Japan), with an accuracy of 0.0005 mm.

The casts and wax patterns of the groups I (CLA-MICRO) and IV (ONDA-CRYL) were flaked in the lower part of a glass fiber flask (BMF1, Classico Dental Products, São Paulo, SP, Brazil) for microwave polymerization with type II dental stone (Pasom; Dental Products, SP, Brazil), and the sets of groups II (CLA-WATER) and III (QC-20) were flaked in the lower part of a traditional brass flask (Safrany; J Safrany Dental Metallurgy, São Paulo, SP, Brazil). Petroleum jelly (Labsynth; Labsynth Chemical Products, Diadema, SP, Brazil) was used as a separating medium between the plaster in the

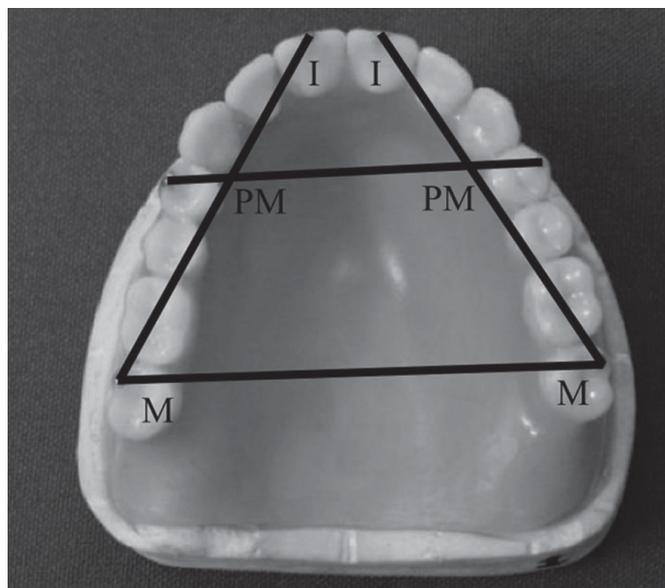


Fig. 1 - Metallic reference pins.

lower part of the flask and the type III dental stone used in the upper portion. After 1 hour the flasks were placed in boiling water to soften the baseplate wax. The flasks were separated, the wax removed, and the stone was cleaned with boiling water and liquid detergent (Ype; Chemical Amparo, SP, Brazil). Two coats of sodium alginate (Isolak; Classico Dental Products, São Paulo, SP, Brazil) were used as a mold separator.

The resins were prepared in accordance with the manufacturer's directions and each sample was packed in accordance with the group assignments: Group I (CLA-MICRO): Classico heat-curing acrylic resin (Classico Dental Products, São Paulo, SP, Brazil) polymerization for 3 min at 35%, 4 min at 0%, and 3 min at 65% power of the 900 W microwave oven (Continental Domestic Products, Manaus, AM, Brazil); Group II (CLA-WATER): Classico heat-curing acrylic resin (Classico Dental Products) polymerization in water bath at 74°C for 9 h (control-group) in the thermo-curing unit (Thermotron Dental Products, Piracicaba, SP, Brazil); Group III (QC-20): QC-20 fast heat-curing acrylic resin (Dentsply, Dental Products, RJ, Brazil) processed in boiling water for 20 min; Group IV (ONDA-CRYL): Onda-Cryl microwave acrylic resin (Classico Dental Products) processed at same conditions of Group I.

After polymerization, the flasks of the groups I and VI were removed from the microwave oven, and the ones of the groups II and III were slowly cooled in the water bath, removed from the thermo-curing unit, and all were bench stored for 3 h. After this period, the dentures were deflaked, polished, and the transverse and anteroposterior distances were measured again. The data collected were subjected to ANOVA and Tukey's test at 5% level of significance.

Results

Considering all distances evaluated, some tooth movement occurred but without statistical difference at 5%

Table 1. Means and standard deviations (mm) of tooth movement for the RP-LP distance considering the polymerization cycle and treatment factor.

Treatment factor	Polymerization cycle			
	CLA-MICRO	CLA-WATER	QC-20	ONDA-CRYL
Before curing	39.07(0.55) Aa	38.70(0.82) Aa	38.65(0.59) Aa	38.24(0.78) Aa
After curing	39.01(0.50) Aa	38.66(0.87) ABa	38.57(0.58) ABa	38.10(0.79) Ba

Means followed by the same uppercase letters in each row and the same lowercase letters in each column are not significantly different (5%)

Table 2. Means and standard deviations (mm) of tooth movement for the RM-LM distance considering the polymerization cycle and treatment factor.

Treatment factor	Polymerization cycle			
	CLA-MICRO	CLA-WATER	QC-20	ONDACRYL
Before curing	51.23(0.85)Aa	51.50 (0.78) Aa	50.97 (0.50) Aa	51.17(0.59) Aa
After curing	51.16(0.72) Aa	51.39(0.81) Aa	50.88(0.46) Aa	50.94(0.58) Aa

Means followed by the same uppercase letters in each row and the same lowercase letters in each column are not significantly different (5%)

Table 3. Means and standard deviations (mm) of tooth movement for the RI-RM distance considering the polymerization cycle and treatment factor.

Treatment factor	Polymerization cycle			
	CLA-MICRO	CLA-WATER	QC-20	ONDACRYL
Before curing	41.79(0.61) Aa	41.70(0.42) Aa	41.55(0.26) Aa	41.68(0.51) Aa
After curing	41.63(0.53) Aa	41.67(0.45) Aa	41.49(0.18) Aa	41.51(0.55) Aa

Means followed by the same uppercase letters in each row and the same lowercase letters in each column are not significantly different (5%)

Table 4. Means and standard deviations (mm) of tooth movement for the LI-LM distance considering the polymerization cycle and treatment factor.

Treatment factor	Polymerization cycle			
	CLA-MICRO	CLA-WATER	QC-20	ONDACRYL
Before curing	40.62(0.72) Aa	40.70(0.53) Aa	40.67(0.31) Aa	40.68(0.54) Aa
After curing	40.52(0.64) Aa	40.56(0.47) Aa	40.53(0.31) Aa	40.61(0.49) Aa

Means followed by the same uppercase letters in each row and the same lowercase letters in each column are not significantly different (5%)

of significance before and after the polymerization (Tables 1-4). For the RP-LP distance, the magnitude of tooth movement was greater for CLA-MICRO (Group I) compared to all other groups after the polymerization (Table 1). The RM-LM, RI-RM, and LI-LM distances had no significant changes after polymerizing the dentures (Tables 2-4).

Discussion

Dimensional changes may modify the planned vertical occlusion dimension, and cause traumas in mucosa and bone loss. Careful measures have been taken to overcome some inaccuracies such as base distortion and displacement of artificial teeth, factors that lead to loss of stability and retention, and necessity of more difficult occlusal adjustments¹.

In the present study, tooth movement occurred in all interactions. However, statistically significant difference ($p < 0.05$) was found only in the RP-LP distance after the

polymerization, with higher value for Group I (Table 1). Three explanations for this phenomenon may be considered: 1) the denture bases were made with 2 mm thickness and, according to previous studies¹³⁻¹⁴, this fact may reduce dimensional change in the base; 2) resin polymerization shrinkage may be, in part, compensated by the thermal expansion of the own resin during the processing¹⁵; and 3) the restrictive effect of investing plaster on keeping the tooth position when the resin induces polymerization and cooling stresses¹⁶. It is also possible that during or after the procedures a great amount of internal stresses was relieved before definitive closure of the flask. Therefore the remaining internal tensions were not able to promote statistically significant tooth movement after deflasking process.

Previous studies reported that the greater degree of base dimensional changes was observed in the denture posterior palatal seal¹⁷⁻¹⁹, with changes of posterior tooth position and vertical dimension¹⁹⁻²⁰. Only the RP-LP distance presented significant dimensional change and the explanation, as

suggested elsewhere²¹, may be related to the complexity of variables that characterize the acrylic resin processing. It is possible that other factors generated a great deal of stress in this region, with displacement of artificial teeth.

The long polymerization cycle in water bath was reported as preferable because less dimensional change occurs in the base²². On the other hand, the fast cycle is characterized by the occurrence of incomplete resin polymerization, with temperature peaks and a great deal of exothermic heat²³. Long and fast cycles in water bath studied in the present study were alike in relation to the linear dimensional stability. To explain this phenomenon it is necessary to consider the complexity of all factors that interact during the complete denture processing²⁴. The dimensional changes expected in the final of the fast cycle were probably insignificant, or minimized by the action of other processing variables.

Most of distances presented regular dimensional stability after processing, and the microwave polymerization groups had similar behavior than the conventional cycles in water bath ones. Last studies advocated in favor to microwave polymerization highlighting the manipulation pattern of resins, its clinical use and dimensional accuracy²⁵⁻²⁶. Other studies reported that basis cured by microwave energy presented the same or a better fit on the cast than others conventionally polymerized²⁷⁻²⁸.

It is possible that the energy emitted by microwave generates a little gradient of temperature between the resin and the cast. That uniform heat result in a fast polymerization and a reduction of stress release²⁹⁻³⁰, and these aspects would lead to a less dimensional distortion. However, these possible properties of microwaving method had little advantage on maintaining the tooth position when compared to the conventional cycles in the present study, especially for CLA-MICRO (Group I) in the RP-LP distance. The microwave groups of the study (Groups I and IV) were comparable to each other for 3 distances (RM-LM, RI-RM, and LI-LM). Braun¹¹ also verified this aspect, concluding that the conventional resins showed similar dimensional change than those resins specially designed to cure by microwave activation.

From a laboratory point of view, this study showed a similar behavior between microwave method and the conventional cycles in water bath. The use of conventional heat-curing acrylic resin for microwave energy polymerization seems not to strongly influence on tooth position change.

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