

Changes in Occlusal Vertical Dimension in Microwave Processing of Complete Dentures

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This study investigated the effect of different microwave curing cycles on the changes in occlusal vertical dimension of complete dentures. Four test groups with 12 maxillary dentures each were evaluated. Groups 1, 2 and 3 were polymerized with different cycles by microwave radiation and Group 4 was the control and cured by water bath. The average pin opening for all groups was less than 0.5 mm. There was no significant difference between the groups polymerized by the microwave method and the control group. However, analyses of the vertical dimension changes showed statistically significant differences between groups 2 (0.276 ± 0.141 mm) and 3 (0.496 ± 0.220 mm).

Key Words: complete denture, vertical dimension, acrylic resin, microwave.

INTRODUCTION

Poly (methyl methacrylate) is the usual resin employed for manufacturing dentures. Since its introduction over six decades ago, there has been a continual search to modify the processing procedures of the resin to improve not only physical and mechanical properties, but also the working properties that facilitate laboratory techniques of denture construction.

In evaluating new denture base materials and processing techniques, one important comparison is changes in the positions of artificial posterior teeth. Changes in occlusal vertical dimension during laboratory procedures of complete dentures are related to intrinsic characteristics of the materials and techniques. Such changes can be caused by packing and closing forces (1), various polymer and monomer systems, the differential coefficient of expansion between gypsum and acrylic resins, and polymerization shrinkage (2,3). These differences can cause some incisal pin opening after processing when the dentures are remounted (4-9).

In 1968, Nishii (7) published the first report in which polymerization of acrylic denture resin was microwave activated. Since then other investigators have

evaluated the physical and mechanical properties (8-11) and the dimensional accuracy (12-13) of denture base resins activated by microwave energy. However, only Nelson et al. (5) related microwave curing to changes in occlusal vertical dimension of complete dentures. They compared complete dentures polymerized conventionally in hot water bath with dentures polymerized by microwave energy. Changes in occlusal vertical dimension were about five times greater in complete dentures polymerized by microwave energy; however, these changes were less than 1 mm.

In 2000, Swords et al. (14) measured the effects of commercial resin type on maxillary complete dentures by periodically comparing the occlusal vertical dimension of polymerized dentures to the wax trial denture fiducial measurements. They observed that time had a significant influence on changes in the maxillary denture mean occlusal vertical dimensions compared with the wax-denture baseline. The mean values of occlusal vertical dimension changes were less than 1 mm and even after 48 h the compression-molded poly(methyl methacrylate) showed no changes in mean occlusal vertical dimension from baseline.

Consani et al. (15) found denture base dimensional changes with three commercial heat-cured acrylic

resins. There were statistical differences in the pattern of distortion in the posterior palatal region among the three acrylic resins, but in the corresponding regions to the distal of canines and mesial of first molars no significant statistical differences were observed.

The purpose of this study was to determine the influence of different curing cycles in a microwave oven on changes in occlusal vertical dimension of complete dentures measured at the incisal pin of the articulator.

MATERIAL AND METHODS

Four experimental groups with 12 maxillary dentures each were evaluated. Group 1 was cured for 3 min at 500W; group 2 for 13 min at 90W with the flask in a vertical position and then with the flask positioned horizontally for 90 s at 500W; group 3 was cured for 3 min at 320W, 4 min at 0W and 3 minutes at 720W; group 4 (control) was cured in a hot water bath for 9 h at 74°C. Groups 1, 2 and 3 were polymerized in a domestic microwave oven (Continental AW-30, Bosch Equipamentos, Manaus, AM, Brazil) and the control group was polymerized in an automatic curing tank (Termotron P-100, Termotron Equipamentos, Piracicaba, SP, Brazil). All experimental groups were compression molded. Two different brands of acrylic resins were used: one specifically designed for microwave polymerization (Onda-Cryl, Artigos Odontológicos Clássico Ltda, São Paulo, SP, Brazil) and the other for

normal heat-activated polymerization (Clássico, Artigos Odontológicos Clássico Ltda) (Table 1).

Denture Fabrication and Vertical Measurements

Forty-eight maxillary stone casts (Herostone Vigodent S/A Ind. Com., Rio de Janeiro, RJ, Brazil) were obtained from an RTV silicone mold (RTV-3120, Reforplás Ind. Com. Ltda, Cubatão, SP, Brazil). Maxillary and mandibular waxed-up trial denture bases were mounted on a Whip-Mix semi-adjustable articulator and the artificial teeth (Dentsply, Petrópolis, RJ, Brazil) were then positioned in maximum intercuspation with the maxillary lingual cusps tightly occluded with the mandibular central fossae and marginal ridges.

First, the mandibular denture was processed conventionally, remounted on the articulator and the occlusal adjustment was made only on the lower teeth. The mandibular denture was unique for all experimental groups. To reproduce maxillary waxed-up dentures (experimental dentures), an RTV silicone mold was obtained from the first maxillary waxed-up trial denture (Figure 1). The maxillary teeth 263/30M (Dentsply) were positioned in the silicone mold, hard wax (Epoxiglass, Diadema, SP, Brazil) was melted and the cast positioned against it. After 30 min the experimental maxillary denture was removed and mounted on a Whip-Mix articulator, using maximum intercuspation as reference. The occlusal vertical dimension was determined by contact of the incisal pin on the incisal table.

The articulator was positioned on a table and a digital caliper, capable of registering changes as small as 0.01 mm was used to measure the distance between upper and lower members of the articulator. Two vertical measurements (Figure 2) were made: the initial one with the experimental denture waxed-up and the final one after the maxillary denture had been processed. Changes in occlusal vertical dimension in this report correspond to the difference between final and initial measurement.

The waxed-up maxillary trial dentures were invested using three layers of laboratory stone (Herodent). A pneumatic press (Delta Máquinas Especiais, Vinhedo, SP, Brazil) was used for trial packing each denture ini-

Table 1. Experimental groups and respective acrylic resin, polymerization method and curing cycles utilized.

	Acrylic resin	Polymerization method	Curing cycles
Group 1	Onda-Cryl	Microwave	3 min at 500W ^a
Group 2	Onda-Cryl	Microwave	13 min at 90W (vertical flask) ^b 1.5 min at 500W (horizontal flask)
Group 3	Onda-Cryl	Microwave	3 min at 320W ^c 4 min at 0W 3 min at 720W
Group 4	Clássico	Water bath	9 h at 74°C ^d

^aKimura et al. (9)

^bTakamata et al. (16)

^cRecomended by the manufacturer Onda-Cryl acrylic resin.

^dWoelfel (17)

tially at 1500 psi and with the final closure of 3500 psi maintained for 30 min. The dentures in groups 1, 2 and 3 were packed with Onda-Cryl denture base resin and the liquid-powder ratio was 7 ml to 21 cm³ and the conventional heat-activated acrylic resin (Clássico) was used for the control group at the same 1 to 3 liquid-powder ratio.

After curing and cooling to room temperature, the processed dentures were removed from the investing material. The adherent stone was cleaned on the teeth and mounting rings. The upper cast and denture was then repositioned on the articulator using the split-cast technique to facilitate accuracy of the final measurement.

RESULTS

All groups produced some small incisal pin opening: group 1 (0.400 ± 0.217), group 2 (0.276 ± 0.141), group 3 (0.496 ± 0.220) and group 4 (0.294 ± 0.163). Group 2 had the lowest mean and Group 3 had the highest mean value of increased incisal pin separation.

The results were analyzed by ANOVA at 95% level of confidence ($p=0.05$) and showed significant interaction between the polymerization cycles for changes of incisal pin opening of the processed complete dentures. The Tukey test for multiple comparisons was applied and no statistically significant differences were found between the control group and the three groups cured by microwave energy. However, the incisal pin opening was significantly less in group 2 than in group 3 (Table 2).

DISCUSSION

In this study, the mean increase of incisal pin

Table 2. Tukey's test.

Comparison	Difference	d.m.s.	Significance
Group 1 x Group 2	0.1242	0.2056	0.381
x Group 3	0.0958	0.2056	0.602
x Group 4	0.1058	0.2056	0.521
Group 2 x Group 3	0.2200	0.2056	0.032*
x Group 4	0.0183	0.2056	0.995
Group 3 x Group 4	0.2017	0.2056	0.056

*Statistically significant ($p<0.05$)

opening during processing in group 3 was 0.20 mm greater than the control group mean. Group 3 was irradiated at 720W for 3 min and water emerged from the flask after polymerization. Gettleman et al. (18) suggested that water in the gypsum controls the rate of heating during microwave curing, and when the gypsum becomes desiccated this may cause acrylic resin contraction and/or stress in the denture base.

The mean vertical change in group 1 was also greater than the control group whereas group 2 exhibited the least mean value for increase in the incisal pin

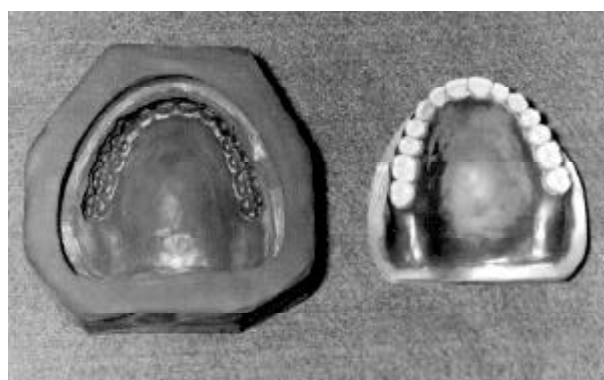


Figure 1. An RTV silicone mold was obtained from the first maxillary waxed-up trial denture.

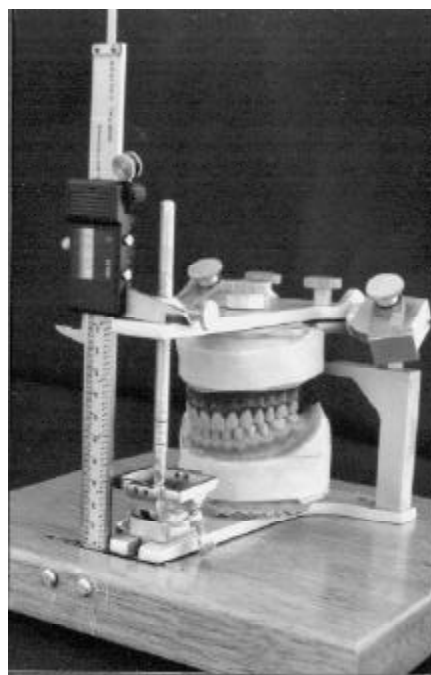


Figure 2. An articulator and a digital caliper, capable of registering changes as small as 0.01 mm, was used to measure the distance between upper and lower members of the articulator.

opening from curing the maxillary complete dentures.

Group 4 had the greatest uniform data. Arioli Filho et al. (19) found similar results when they analyzed tooth movement during microwave and conventional polymerization of maxillary dentures.

In this study, all curing cycles produced a small increase of the incisal pin opening during processing the maxillary complete dentures. Group 2 was significantly different from group 3. However, the dentures cured by different microwave cycles exhibited no significant difference from those cured by the water bath method (Table 2). Nelson et al. (5) found the mean increase in incisal pin opening approximately five times greater using the microwave technique than using the conventional processing method. Differences between types of ovens or materials may create such contrasting results.

Microwave curing has an advantage of saving time with somewhat cleaner processing equipment and handling compared with the conventional processing method. However, further studies will be needed to indicate the range of wattage/time combinations in microwave ovens for the most accurate dentures.

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RESUMO

Barbosa DB, Compagnoni MA, Leles CR. Alteração da dimensão vertical de oclusão de próteses totais polimerizadas através da energia de microondas. *Braz Dent J* 2002;13(3):197-200.

Este estudo avaliou o efeito de diferentes ciclos de polimerização sobre a dimensão vertical de oclusão em próteses totais. Quatro grupos experimentais, cada um contendo 12 próteses totais superiores foram avaliados. Os grupos 1, 2 e 3 foram polimerizados através da energia de microondas em diferentes ciclos e para o Grupo 4 a polimerização foi realizada em banho de água quente e este grupo foi utilizado como controle nesta pesquisa. Os resultados evidenciaram uma média de afastamento do pino incisal da mesa incisal do articulador inferior a 0,5 mm para todos os grupos avaliados. Não existiu diferença significante entre os grupos polimerizados por microondas e o grupo controle. No entanto, existiu diferença significante entre as alterações verticais dos grupos 2 ($0,276 \pm 0,141$ mm) e 3 ($0,496 \pm 0,220$ mm).

Unitermos: prótese total, dimensão vertical, resina acrílica, microondas.

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