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The Effect of Acrylic Resin Recycling on The Hardness of Artificial Acrylic Resin Denture Teeth

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ABSTRACT

Aims: To evaluate the effect of recycling of denture base on the surface hardness of artificial acrylic denture teeth. **Materials and methods**: thirty identical artificial acrylic denture teeth of two types (cross linked and conventional denture teeth) were positioned within polyvinylchloride tubes filled with melted wax to prepare a samples within heat activated denture resin to be tested for Vickers hardness test before and after recycling by water bath for 1 hours at 100 °C and by microwave for 30 minutes at 80 watt then for 1.5 minute at 500 watts. **Results:** Showed that the water bath and microwave recycling of denture base will not affect the hardness of conventional and cross linked denture teeth, and cross linked denture teeth are more wear resistance after recycling by microwave and water bath. **Conclusions**: Artificial denture teeth will not affect by double cycle of curing produced of acrylic denture base.

Key word: Double curing, acrylic denture teeth, recycling.

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INTRODUCTION

Relining, rebasing, repairing, and disinfection by water bath and microwave require a second cureing cycle after curing the acrylic resin denture–base material. A second heat–cure and microwave cycle may affect the concentration of MMA monomer, which may in turn affect the mechanical properties of the prosthesis[1].

Dentures submitted to microwaving for up to 16 min presented no dimensional changes[2]. Residual monomer of repaired denture base was reduced with additional curing cycle[3].

Relining of the conventional resin cured by water bath or microwaves energy showed a better adaptation, and the highest number of pores[4].

Microwave postpolymerization irradiation significantly increased the flexural strength of the autopolymerizing reline materials[5].

The microwave curing method in reline give higher transverse strength and tensile bonding values for the relined samples than water bath curing methods[6].

The effect microwave irradiation on the hardness of denture base resins was not clinically significant[7].

Artificial teeth are often necessary for prosthodontic rehabilitation when natural teeth are lost. Acrylic resins and porcelains have been used for the fabrication of artificial teeth; however, neither type completely accomplishes the requirements for an ideal prosthetic tooth[8].

New types of artificial teeth using modified acrylic resin that incorporate crosslinking agents and composite resin-containing filler have become increasingly common. Cross–linking agents are generally used to improve strength and crazing resistance[9].

Cross–linking has been introduced as a wear resistant material and used as a denture tooth material for more than a decade [10].

Excessive wear of acrylic resin teeth has been a concern to both the patient and the dentist because of unfavorable associated sequelae[11].

Hardness is considered to be related to wear resistance and is the most commonly examined mechanical property indicator for synthetic restorative and artificial tooth materials[11–13].

Loyaga–Rendon et al.,[14] were used Vickers hardness (VHN) to determined the hardness of of new commercially available types of acrylic resin and composite resin artificial teeth.

Campanha etal., [15] investigate a denture teeth with respect to the effect of microwave sterilization and water immersion on Vickers hardness and they found that microwave sterilization had no effect on the hardness of most of the acrylic resin denture teeth

The combination of water and increased temperature during microwave sterilization could, in theory, affect the VHN of acrylic resin denture teeth[15].

The purpose of this study was to examine the Vickers hardness of two types of commercially available cross–linked acrylic and conventional acrylic resin artificial teeth subjected to additional curing cycle by microwave and conventional water bath procedure.

MATERIALS AND METHODS

Thirty identical posterior (molar) acrylic denture teeth of two types (cross linked acrylic resin teeth (CL) and conventional acrylic (CA) denture teeth) were positioned within polyvinylchoride tubes (20 mm diameter and 20 mm length) which were previously filled with melted wax [16].

The teeth were placed in the center of the tube with axial surface parallel to the long axis of the tube. Then each tube was invested in the usual denture flasks in dental stone, the wax was eliminated, the mould was packed with denture resin (Major 2 Base, Major prodotti dentari, Italy). The denture resin was cured by water bath for 1 hour at 100 °C (manufacture instruction) after curing the specimens were removed and the occlusal surfaces of the acrylic resin denture teeth were ground flat using 600, 800, 1200grit silicon carbide paper with running water as coolant[15]. The samples were stored in distilled water for 48 hours at 37°C.

The recycling of the samples(4 groups) was carried out by water bath and microwave in which 5 samples for each type of denture teeth (CL, CA) was treated separately, by reinsertion of the samples in water bath for 1 hour, and for microwave the samples was place for 30 minutes at 80 watt energy then at 500 watt for 1.5 minute[17]. Then the samples was tested for surface hardness by Vickers hardness test at 5 different site for each samples and the mean was calculated for each sample.

The data was analyzed statistically by descriptive, Analysis of variance (ANOVA) ($p \geq 0.05$) and Duncan's Multiple range test.

RESULTS

Tables (1and 2) showed that Vickers hardness number (VHN) was no statistically significant between conventional acrylic denture teeth (CA) before (16.8$\pm$ 0.83) and after recycling by water bath (15.8$\pm$0.83) and microwave (15.8$\pm$ 1.48).

Table (1): Mean and standard deviation of vickerts hardness number for conventional acrylic denture teeth

Recycling technique	N	Mean	$\pm$ SD
Control	5	16.2	0.83
Water bath	5	15.8	0.83
Microwave	5	15.8	1.48

SD: standard deviation; N: Numbers.

Table (2): Analysis of variance for Vickers hardness number of conventional acrylic denture teeth

Source of variance	Sum of Squares	Df	Mean Square	F–value	*P*–value
Between Groups	3.333	2	1.667	1.389	0.287
Within Groups	14.400	12	1.200		
Total	17.733	14			

Tables (3 and 4) demonstrated that there was no significant differences between cross linked acrylic denture teeth (CL) recycled by water bath (19.4±1.14), microwave energy (19.44±0.7) and control samples (19.82±0.55).

Table (3): Mean and standard deviation of vickerts hardness number for cross linked acrylic denture teeth

Recycling technique	N	Mean	± SD
Control	5	19.82	0.55
Water bath	5	19.4	1.14
Microwave	5	19.44	0.70

SD: standard deviation

Table (4): Analysis of variance for Vickers hardness number of cross linked acrylic denture teeth

Source of variance	Sum of Squares	Df	Mean Square	F–value	*P*–value
Between Groups	.537	2	.269	.383	.690
Within Groups	8.420	12	.702		
Total	8.957	14			

Table (5) expressed that there was significantly differences between VHN of CL denture teeth and CA denture teeth. Table (6) showed that CL denture teeth were significantly higher VHN than CA denture teeth.

Table (5): Analysis of variance for Vickers hardness number for cross linked and conventional acrylic denture teeth

Source of variance	Sum of Squares	df	Mean Square	F–value	*P*–value
Between Groups	91.594	5	18.319	19.266	.000
Within Groups	22.820	24	.951		
Total	114.414	29			

Table (6): Duncan's Multiple range test of Vickers hardness number for cross linked and conventional acrylic denture teeth

variables	N	Mean	Duncan's groups
Control CA	5	16.8	A
Water bath CA	5	15.8	A
Microwave CA	5	15.8	A
Control CL	5	19.4	B
Water bath CL	5	19.4	B
Microwave CL	5	19.8	B

Groups with different letter were significantly different.

DISCUSSION

In this study, 2 types of acrylic resin denture teeth(CA and CL) were investigated with respect to the effect of water bath and microwave energy recycling. The results showed that water bath and microwave recycling had no effect on VHN for CL and CA denture teeth (Table 2 and 4) .

The high temperatures associated with the movements of molecules probably cause the water molecules to diffuse more rapidly into the polymer. This absorption process facilitates the movement of polymeric chains under load, thus lowering the hardness of the polymer. Therefore, it is likely that the reduction in VHN values was dependent on water sorption rather than the water bath heating and microwave energy per seconds [18,19].

So that the lower effect of microwave energy and water bath heating probably due to the duration needed to stabilize the water uptake of materials and the effect of microwave and water bath heating on water uptake was short.

This result is disagree with Campanha *et al*.,[15] who reported that the two cycles of microwave sterilization decreased the VHN of several types of acrylic resin denture teeth. This differences may be due that they used high microwave power (650 watt) with double time of recycling.

The CL teeth had higher surface hardness number than CA teeth (Table 5 and 6) this result may be due to that the CL resin denture tooth is fabricated from an unfilled, highly cross–linked, interpenetrating network. Such characteristics would, in theory, decrease the water diffusion coefficient of the polymer. Therefore, it may be assumed that a lower rate of water absorption thus resulting in low VHN [20–22].

CONCLUSIONS

Recycling of denture base by water bath or by microwave will not affect the hardness of artificial acrylic denture teeth. Cross linker denture teeth are harder than conventional denture teeth with recycling by water bath or microwave energy.

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