

# Effect of the Curing Methods on the Surface Hardness of Different Thickness on Heat-Cured Acrylic Resin.

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## ABSTRACT

**Aims:** To evaluate the surface hardness of the heat-cured acrylic resins with two different thicknesses cured by two curing methods conventional water bath and microwave energy. **Materials and Methods:** Heat-cured acrylic resin was used in this study. Rectangular specimens were prepared with two different thicknesses (3 and 6mm) and cured by two different curing methods, conventional water bath and microwave energy methods. The specimens were divided into two groups according to the curing method and specimens thickness. Forty specimens were prepared, ten specimens for each group. The surface hardness was evaluated with Rock well hardness tester. Mean values wear compared statistically with one way analysis of variance (ANOVA) followed by Duncan's multiple range test to determine the significant different among the groups at ( $p < 0.05$ ) level of significance. **Results:** The results showed that there is a highly significant difference of the means value of the surface hardness among the four tested groups. Specimens cured by conventional water bath with 3mm thickness have the highest value in relation to 6mm thickness of specimens cured by microwave energy. **Conclusions:** The curing method, and specimens thicknesses have a significant effect on the specimens surface hardness value. The specimens that cured by the conventional water bath method have a higher values than that cured by the microwave energy curing method and the thicker specimens have a lower values than the thinner one in both curing methods.

**Key words:** Surface hardness, heat-cured acrylic resin, conventional water bath, microwave.

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## INTRODUCTION

Dentures, jacket crowns as a conservative alternative to the crown and bridge restorations for interim esthetic treatment, veneers for cast gold restorations and occlusal splints in the treatment of patients with temporomandibular joint pain or bruxism are constructed from heat-cured acrylic resins (polymethyl methacrylate), using the conventional polymer / monomer dough molding and cured water bath system. Advantages of acrylic resin are low cost, ease of manipulation, and ability to match tooth structure<sup>(1,2)</sup>.

The low knoop hardness number of the denture base plastic (17 kg/mm<sup>2</sup> dry, 15 kg/mm<sup>2</sup> wet) indicates these materials

may be scratched easily and abraded<sup>(3)</sup>. The hardness of the material is a parameter used to predict wear<sup>(4)</sup>.

There has been a continuous search to reduce the processing time and enhance the physical properties of denture base acrylic resins<sup>(5,6)</sup>. Ilbay *et al.*,<sup>(7)</sup> reported that conventional acrylic resins used for the production of denture base can also be used in the microwave method. The advantages of polymerizing denture base resin by microwave energy are a greatly reduced polymerizing time, a cleaner method of processing, and a denture base with superior adaptation to the dental cast<sup>(8,9)</sup>.

The aim of this study was to evaluate

the surface hardness of the heat-cured acrylic resins of different thicknesses. 3mm and 6mm cured by microwave energy and conventional water bath curing method.

## MATERIALS AND METHODS

The tested material used in this study was the heat-cured acrylic resins Major Base 2 (Major prodotti, dentari, S.P.A, Italy). The resin was mixed at powder / liquid ratio of (2.5/1) by weight<sup>(10,11)</sup>. Forty acrylic resin specimens were prepared as a rectangular with two different thickness as 30 X 15 X 3 ± 0.03 mm, and 30 X 15 X 6 ± 0.03 mm length, width and thickness respectively<sup>(12,13)</sup>. Specimens were cured by two different curing methods conventional water bath and microwave energy curing method. Specimens were divided into four groups according to the specimens thickness and curing methods. Group I specimens were 3mm in thickness. Group II specimens were 6mm in thickness. Group I and Group II specimens were cured by water bath. Group III specimens were 3mm in thickness. Group IV specimens were 6mm in thickness. Group III and Group IV specimens were cured by microwave energy curing method. For conventional water bath method curing was carried out by placing flask in a thermostatically controlled water bath. Instruction of manufacturer for curing cycle were followed :1.5 hours at 74°C followed by 30 minutes at 100°C<sup>(14)</sup>. Curing cycle For microwave technique, Fiber Reinforced Plastic (FRP) flask was placed in the microwave oven (Samsung, Model RE-570 D, 0.6 cuft, Korea) for 30 minutes at low setting (80 watts): 15 minutes per side, followed by 1.5 minutes at the high setting (500 watts)<sup>(15)</sup>. All specimens were fully saturated before testing, by immersion in water at 37 °C until a constant weight was obtained<sup>(16)</sup>. Each specimen dried with absorbent paper, and placed in the hardness tester<sup>(4)</sup>. The surface hardness was evaluated with Rockwell hardness tester (Wolpert, Germany). At least six areas were measured per specimen<sup>(17)</sup>.

Statistically mean values and standard deviation were calculated. means compared with one way analysis of variance (ANOVA) followed by Duncan's multiple

range test to determine the significant difference among the groups at ( $p \leq 0.05$ ) level of significance.

## RESULTS AND DISCUSSION

The results of this study are shown in Tables (1 and 2). The results in Tables (1) showed ANOVA for the means of the surface hardness of the tested groups. The results showed that there was a highly significant difference of the means among four tested groups at  $P \leq 0.01$ . The results in Tables (2) showed Duncan Multiple Range test for surface hardness of the tested groups. The result showed the value of the mean of the surface hardness of Group I (specimens 3mm in thickness cured by water bath curing method) was 119.5 kg/mm<sup>2</sup> which is the highest value, Group II (specimens 6mm in thickness cured by water bath curing method) has lower value than that of the Group I (118.7 kg/mm<sup>2</sup>), while Group IV (specimens 6mm in thickness cured by microwave energy curing method) has the lowest value 99.4 kg/mm<sup>2</sup>, and Group III (specimens 3mm in thickness cured by microwave energy curing method) has an intermediate value between that of Group II and Group IV (111.6 kg/mm<sup>2</sup>). The results indicated that the specimens thickness and curing method have a significant effect on the mechanical properties of the cured resin. This results disagree with the finding of Reitz *et al.*, and others<sup>(18-21)</sup> in that there are no significant differences in mechanical properties of acrylic resins polymerized by microwave and conventional curing methods. This can be explained in that the microwave oven for curing resin was much faster than a conventional water bath, and degree of curing also increased a little. Microwave processing temperatures beyond 100.3 °C caused vaporization of the monomer and produced porosity<sup>(17)</sup>. Internal porosity may develop in the thick portion of a denture base as a result of the monomer, when the temperature of the resin increased above the boiling point of these phases. Internal porosity weakened the denture base<sup>(1)</sup>. So according to this explanation the thicker specimens that cured by microwave energy have the lowest values of surface hardness.

**Table (1): ANOVA for surface hardness of the tested groups.**

Source of variance	DF	Surface hardness (kg/mm <sup>2</sup> )		F-value	P-value
		Sum of square	Mean of square		
<b>Tested groups</b>	3	2597.00	865.67	92.37	0.000 *
<b>Error</b>	36	337.40	9.37		
<b>Total</b>	39	2934.40			

df : Degree of freedom

**Table (2): Duncan Multiple Range test for surface hardness of the tested groups**

Tested Groups	Surface hardness ( kg /mm <sup>2</sup> )		
	No	Mean± SD	*Grouping
<b>Group I</b>	10	119.5±0.97	A**
<b>Group II</b>	10	118.7±0.48	A**
<b>Group III</b>	10	111.6±3.50	B
<b>Group IV</b>	10	99.4±4.90	C

No: Samples number; SD : Standard deviation; Group I : Specimens 3mm in thickness cured by water bath curing method; Group II: Specimens 6mm in thickness cured by water bath curing method; Group III: Specimens 3mm in thickness cured by microwave energy curing method; Group IV: Specimens 6mm in thickness cured by microwave energy curing method.

## CONCLUSION

The values of the surface hardness of the specimens cured by the microwave energy curing method were lower than that cured by the conventional water bath curing method with two different thickness (3 and 6mm ) and the thicker specimens have the lower values than that of the thinner one when cured by both curing methods.

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