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Evaluation of the effect of curing techniques on colour property of acrylic resins

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ABSTRACT

This study was carried out to evaluate the colour property of two types of acrylic resin materials cured by microwave technique in comparison with that cured by conventional water bath technique.

Two types of heat cured acrylic resin materials were selected: Quayle–Dental and Major–base types. Seventy–two samples (30×20×1.5 mm) were prepared and divided into four experimental groups: Quayle–Dental and Major–base groups were cured by microwave technique and the others Quayle–Dental and Major–base groups were cured by water–bath technique. The number of samples for each group was 18.

The colour property for the samples was evaluated using computerized ultraviolet–visible spectrophotometer with accuracy up to 0.001 nm. The absorbed light was measured which is also termed the optical density.

The results of this study showed that there were no significant differences in optical density for acrylic resin samples cured by microwave and water–bath techniques, and the acrylic resin with smaller particle size (Quayle–Dental) showed higher optical density (colour property) than that of larger particle size (Major–base).

Key Words: Optical density, colour property, microwave technique.

الخلاصة

أجريت هذه الدراسة لتقييم صفة اللون لمادتين من الأكريلك الراتنجي المبلمرة بطريقة الموجات الدقيقة مقارنة بالمبلمرة بتقنية الفرن المائي.

استُخدم نوعان من مادة الأكريلك الراتنجي المعامل حرارياً (Quayle–Dental) و (Major–base). تم تحضير اثنان وسبعون نموذجاً (٣٠×٢٠× ١.٥ ملم) وقسِّمت إلى أربع مجاميع متساوية: مجاميع (Quayle–Dental) و (Major–base) مبلمرة بتقنية الموجات الدقيقة والمجاميع الأخرى من نفس المواد بُلمرت بتقنية الفرن المائي. وكان عدد نماذج كل مجموعة ١٨.

قيِّمت صفة اللون للنماذج باستخدام جهاز طيف الأشعة فوق البنفسجية المرئية المبرمج وبدقة تصل إلى ٠.٠٠١ نانوميتر، وقد تم قياس الضوء الممتص والذي يمثل شدة الضوء.

أظهرت نتائج هذه الدراسة عدم وجود فرق معنوي في شدة الضوء للنماذج المبلمرة بتقنية الموجات الدقيقة والفرن المائي. كما بينت النتائج أعلى شدة للضوء (صفة اللون) للراتنج الأكريلي (Quayle–Dental) ذو الحبيبات الصغيرة نسبة إلى الراتنج الأكريلي ذو الحبيبات الكبيرة (Major–base).

INTRODUCTION

There has been a continuous research to reduce the processing time, and enhance the physical properties of denture base acrylic resin material.[1] The use of microwave energy to polymerize acrylic resin denture materials was first reported by Nishii.[2] The use of microwave technique

for polymerization denture base acrylic resin has been encouraged, by the time saved, and cleaner processing method.[3] Numerous studies have compared the properties of microwave–activated acrylic resin, and water bath activated resins.

Concurring results were reported for properties such as transverse strength, hardness,[4, 5] stiffness,[3] adaptation.[4] Residual monomer and found to be the same[6, 7] or increased[8] in microwave cured samples compared to hot water bath curing. The presence of porosities in acrylic resin was found to be the same for the two curing methods in thin (less than 2.5–3.0 mm) samples,[3, 5] increased after micro-wave curing in thicker samples.[5, 8]

The colour of denture base acrylic resin is another important property. Discolouration of acrylic resin may occur which result in aesthetic problem[9] so that colour and translucency should be maintained during processing stages.[10, 11]

This study evaluated the colour property of microwave cured acrylic resin compared to that of conventional water bath cured resin, and the effect of type of acrylic resin on its colour property.

MATERIALS AND METHODS

Two types of heat–cured resins, Major–base (Major Prodotti Dentari SPA, Italy) and Quayle–Dental (Quayle–Dental Ltd, UK) were evaluated for colour property.

Samples were prepared with uniform dimensions of 30×20×1.5 mm (length, width, and thickness respectively) using modeling wax (Major Prodotti Dentari SPA, Italy).

Seventy two samples were prepared and divided into four equal experimental groups: Major–base and Quayle–Dental resins groups were cured by microwave technique, Major–base and Quayle–Dental resins groups were cured by conventional water bath technique; number of samples for each group was 18 and all samples were tested using microscope to ensure that all samples were free from porosity.

For microwave curing technique, fiberglass–reinforced plastic flask (FRP), which was prepared locally in previous work,[12] was used with dental stone (Silky–Rock, Whipmix Corporation, USA). For wax elimination, the flask was microwaved for 1 minute at high setting (500 watts). The stone surfaces of the flask were coated with a separating medium before processing (Isol Major, Major Prodotti Dentari SPA, Italy) and allowed to dry according to the manufacturer's instructions. Acrylic resin was mixed according to the powder/liquid ratio recommended by the manufacturers. All samples were trial packed and final closure of FRP flask was completed by placing Teflon nuts and washers in their correct position and the nuts were tightened securely. For curing of acrylic resin, the FRP flask was put in the microwave oven (Samsung, Model RE–570 D, Korea) for 30 minutes at the low setting (80 watts), 15 minutes persid, followed by 1 ½ minutes at the high setting (500 watts).[13]

For conventional water bath curing technique, metal Ash flask (Ash, England) was used and the same processing steps were followed. For curing of acrylic resin, the metal flask was placed in a thermostatically controlled water bath (Kavo GmbH, West Germany) for 30 minutes at 70 ºC, then processed at 100 ºC for 30 minutes according to the manufacturer's instructions.

The samples were recovered after polymerization and identified by placing a series of notches indicate the material, the sample number and the front surface of each sample.

The acrylic samples were immersed in distilled water for 7 days at 37 $\pm$ 1 ºC for conditioning of the samples.[14]

After that, evaluation of the colour property was performed using a computerized ultraviolet–visible spectrophotometer (CECIL, CE 1021, England) at 350 nm. The absorbed light was measured with accuracy up to 0.001 and it is also termed the optical density (colour property).

Statistical analysis of the data included calculation of the mean, standard error, standard deviation, analysis of variance (ANOVA) and Duncan's Multiple Range Test for the four groups.

RESULTS

Means and standard deviations for optical density for Quayle–Dental and Major acrylic resins cured by conventional water bath and microwave techniques are listed in Table (1).

In order to show if there are significant differences among the groups, ANOVA was conducted and listed in Table (2) which shows that there are significant differences ($p < 0.001$) among the experimental groups, and the results of optical density of Major acrylic resin was significantly lower (0.8308) than that of Quayle–Dental acrylic resin material (2.0585) (Figures 1 and 2).

Table (1): Means, standard error and standard deviation of optical density of colour for the four groups

Group	No. of Sample	Mean (nm)	± Standard Error	± Standard Deviation
Water bath–Quayle Dental	18	2.0585	0.0510	0.2164
Water Bath–Major	18	0.8308	0.1017	0.4315
Microwave–Quayle Dental	18	2.0707	0.0436	0.1854
Microwave–Major	18	0.8735	0.0556	0.2362

Table (2): Analysis of variance for the levels of curing techniques and type of acrylic resins

	Sum of Squares	d.f	Mean Square	F–value	Significance
Between Groups	26.478	3	8.826	109.229	0.0001*
Within Groups	5.495	68	0.0808		
Total	31.973	71			

d.f: Degree of freedom.
* Highly significant difference.

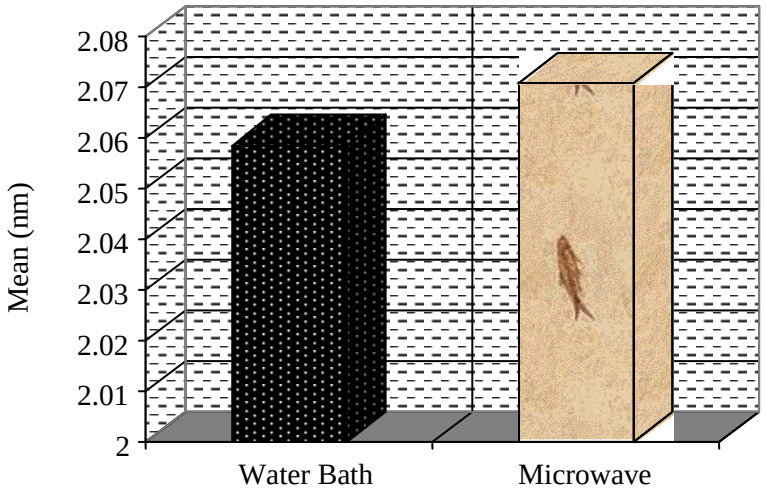

Figure (1): Optical density of colour of Quayle Dental acrylic resin cured by two techniques

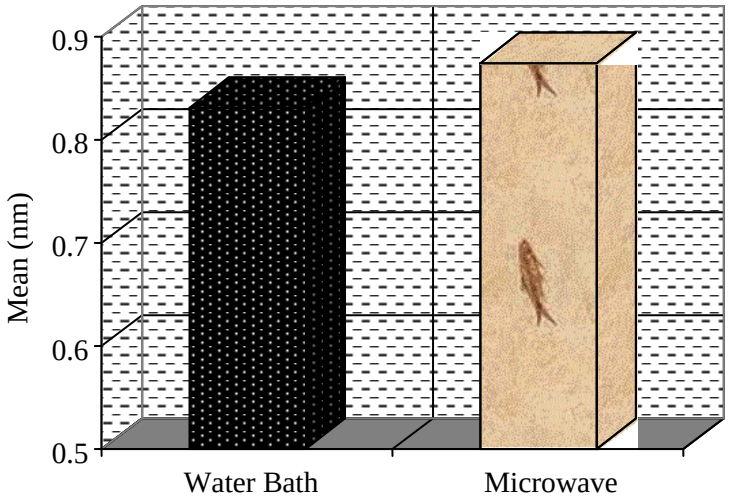

Figure (2): Optical density of colour of Major–base acrylic resin cured by two techniques

Duncan's Multiple Range Test (Table 3) shows that there are significant differences in optical density for Quayle Dental and Major acrylic resin, while regarding curing techniques this test (Table 3) shows that there are no significant differences in optical density for samples cured by water bath or microwave techniques.

Table (3): Duncan's Multiple Range Test for the four groups

Group	No. of Sample	Mean (nm)	Duncan's Group*
Microwave–Quayle Dental	18	2.0707	A
Water Bath–Quayle Dental	18	2.0585	A
Microwave–Major	18	0.8735	B
Water Bath –Major	18	0.8308	B

* Means with different letters are statistically significant.

DISCUSSION

The results of this study revealed that there were no significant differences in optical density (colour property) for microwave cured acrylic resin and water bath cured acrylic resin.

The researches showed that the main two factors that have a major role in colour property of acrylic resin are residual monomer content and porosity caused by over heating.[15, 16]

In this study, lower wattage (80 watts) and longer curing cycle (30 minutes, 15 minutes persid) followed by 1 ½ minutes at high setting (500 watts) was used for microwave curing method. This curing cycle facilitated the exothermal heat to be dissipated quickly to the surrounding investing material, and the low wattage that was selected for the curing facilitates spreading of heat in gradual manner so that boiling point (100.3 ºC) of the monomer is not reached in comparison with other techniques.[17] So in this study the samples that were cured by microwave technique (Figures 1 and 2, Table 1) were relatively free of porosities and as the selected curing cycle includes 1 ½ minutes at the high setting (500 watts), this allowed removal of high percentage of residual monomer content in the acrylic resin.[13]

While the curing cycle for conventional water bath technique was selected in this study according to the manufacturer's instructions.

Also the results of this study showed

that the optical density (colour property) of the Major acrylic resin was significantly lower than that of Quayle–Dental acrylic resin (Tables 2 and 3). The possible explanation for these findings is that the particle size of the Quayle–Dental acrylic is smaller than that of the Major–acrylic resin.[18,19]

The smaller particle size will facilitate the surface wetting of the particles by monomer followed by subsequent interaction with larger particles and enhanced matrix formation which is characterized by higher optical density for Quayle–Dental acrylic resin.[18]

CONCLUSIONS

There are no significant differences in optical density (colour property) for acrylic resin cured by microwave and water bath techniques.

Acrylic resin with smaller particle size has highest optical density (colour property) than that of larger particle size.

REFERENCES

1) Williamson DL, Boyer DB, Aquilino SA, Leary JM. Effect of polyethylene fiber reinforcement on the strength of denture base resins polymerized by microwave energy. *J Prosthet Dent*. 1994; 72: 635-638.
2) Nishii M. Studies on the curing of denture base resins with microwave irradiation with particular reference to heat–curing resins. *J Osaka Dent Univ*. 1968; 2: 23-40.
3) Levin B, Sanders JL, Reitz PV. The use of microwave energy for processing acrylic resins. *J Prosthet Dent*. 1989; 61: 381-383.
4) Sanders JL, Levin B, Reitz PV. Com-parison of the adaptation of acrylic resin cured by microwave energy and conventional water bath. *Quintessence Int*. 1991; 22: 181-186.
5) Reitz PV, Sanders JL, Levin B. The curing of denture acrylic resins by microwave energy: Physical properties. *Quintessence Int*. 1985; 16: 547-551.
6) Truong UT, Thomasz FGV. Comp-arison of denture acrylic resins cured by boiling water and microwave ener-gy. *Aust Dent J*. 1988; 33: 201-204.
7) Shlosberg SR, Goodacre CS, Munoz CA, Moore BK, Schnell RJ. Micro-wave energy polymerization of poly (methyl methacrylate) denture base resin. *Int J Prosthodont*. 1989; 2: 453-458.
8) Al–Doori D, Huggett R, Bates JF, Brooks SCA. Comparison of denture base acrylic resins polymerized by microwave irradiation and by conventional water bath curing systems. *Dent Mater*. 1988; 4: 25-32.
9) Engelmeier RL. Complete denture aesthetic. *Dent Clin North Am*. 1996; 40: 71-83.
10) Beatty MW, Mahanna GK, Jia W. Ultraviolet radiation induced color shifts occurring in oil–pigmented max-illofacial elastomer. *J Prosthet Dent*. 1999; 82: 441-446.
11) Polyzois GL, Zissis AJ, Yannikakis SA. The effect of glutaraldehyde and microwave disinfection on some prop-erties of acrylic resin. *Int J Prostho-dont*. 1999; 8: 150-154.
12) Hasan RH. Denture teeth bond strength to heat water bath and microwave cured acrylic denture base materials: A comparative study. MSc thesis. College of Dentistry. University of Mosul. 2002.
13) Al–Azzawi SI. Evaluation of some physical and mechanical properties of acrylic denture base materials cured by two different types of microwaves irradiation. MSc thesis. College of Dentistry. Baghdad University. 1998.
14) Anusavice KJ. Philip's Science of Dental Materials. 10th ed. WB Saunders Co. Philadelphia. 1996; p: 249.
15) Austin AT, Basker RM. Residual monomer levels in denture bases. The effects of varying short curing cycles. *Br Dent J*. 1982; 153: 424-426.
16) May KB, Shotwell JR, Koran A, Wang RF. Color stability: Denture base resins processed with the microwave method. *J Prosthet Dent*. 1996; 76: 581-589.

17) Atkinson HF, Grant AA. Exothermic reaction of poly (methyl methacr-ylate). *Aust Dent J*. 1966; Feb: 38-42.

18) Keller JC, Lautenschlager EP. Poro-sity reduction and its associated effect on the diametral tensile strength of activated acrylic resin. *J Prosthet Dent*. 1985; 53: 374-397.

19) Al–Abbas ZM. Evaluation of the effect of some denture cleansers on the colour of acrylic resin denture base materials. MSc thesis. College of Dentistry. University of Mosul. 2002.

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