Evaluation Amount of Residual Monomer in Two Types of Denture Base Materials Heat and Light Cure Acrylic Reinforced with Silainated Glass Fiber

Raghdaa K. Jassim

Raghdaa K. Jassim*
B. D. S, M.Sc, Ph. D - Assist. Prof. College of dentistry Baghdad University
Aseel A. A. Radhi
B.D.S - Assist. Lec, university of Karbala M.Sc. Student during research

Aseel A. A. Radhi

ABSTRACT

Background: Residual monomer is one of the undesirable factors affecting the properties of acrylic resin denture bases this study compared the influence of addition silanated glass fiber(SGF) to two types of acrylic (heat &light cured resin) on the amount of residual monomer methyl methacrylate (MMA) at different periods of time.

Materials and Methods: specimens of heat and light cured denture base materials reinforced with(2mm length, 2wt%)(SGF) were measured for their amount of residual monomer (MMA)by using high-performance liquid chromatography (HPLC) after(3days, 7days, 14days, and 30days).

Results: The amount of residual monomer in reinforced groups with (SGF) either heat or light cured resin was less than non reinforced groups. The amount of residual monomer in heat cured resin was higher significance than light-cured resin and the amount of residual monomer of both types of acrylic decreased with time increased.

conclusion: The addition of 2% silainated glass fiber to the both heat cured & light cured resin slightly decrease the amount of residual monomer.

KEYWORDS

glass fiber, heat cure, light cure, monomer

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تقيم المونمر المتبقي في نوعين من مادة الطقم الراتنج الاكريل الحراري والضوئي المقوى بالالياف الزجاجية

رغداء كريم
استاذ مساعد, كلية طب الاسنان - جامعة بغداد
اسيل أ. راضي
مدرس مساعد , كلية طب الاسنان - جامعة كربلاء

المستخلص

مقدمه:المونمر المتبقي بعد البلمرة احد العوامل الغير مرغوب فيها والمؤثره على خواص مادة الطقم الراتنج الاكريل . هذه الدراسة تقارن تاثير اضافة الالياف الزجاجية (silanized) الى نوعين من الاكريل (المبلمر حراريا والمبلمر ضوئيا) خلال فترات زمنية مختلفة .

المواد والعمل: قيست كمية المونمرفي عينات من الاكريل المبلمر حراريا وضوئيا مقواة ب٢ملم طول و ٢٪وزن من الالياف الزجاجية باستعمال جهاز (high performance liquid chromatography)بعد ٣ يوم,٧ يوم,١٤ يوم و ٣٠ يوم.

النتائج ان كمية المونمر المتبقي بالمجاميع المقواة بالالياف الزجاجية المبلمرة حراريا اعلى بكثير من المبلمرضوئيا.وان كمية المونمر المتبقي في كلا نوعي البوليمر قلت كلما ازداد الوقت

الاستنتاجات اضافة ٢٪ من الالياف الزجاجية الى الاكريل المبلمر حراريا وضوئيا تقلل كمية المونمر المتبقي.

INTRODUCTION

Polymerization of denture base resins can be accomplished with different processing methods. Despite the various methods used to initiate the polymerization reaction, the conversion of monomer to polymer is not complete and some non reacted monomers called residual monomers will be left. Residual monomer considered undesirable property it may diffuse from the acrylic resin into saliva [1] and to the mucous membrane resulting in irritation or allergic reaction [2, 3, 4].

Residual monomer had an adverse effect on the mechanical properties of denture base resin, such as hardness , water sorption, , tensile strength [5, 6,7] and flexural strength [8]. A number of methods have been developed to determine the level of residual methyl methacrylate monomer such as infrared spectroscopy [9] and gas chromatography [10, 11], but high performance liquid chromatography (HPLC) has also expanded its application in analytical chemistry [12, 13]. There are some types of material that added to acrylic resin in order to improve its mechanical properties. Glass fiber reinforced polymers enhance the mechanical properties of the polymers especially

*: E- mail: ragdaa3kareem@yahoo.com

the silanated glass fiber because of their good initial bonding between the glass fiber and polymers via the interface that made from silane coupling agent [14]. Some authors reported that the use of glass fiber reinforcement in heat- cured acrylic resin increase the release of residual methyl methacrylate [15,16]. Although this increase was significant, lowest residual MMA content was found successively in reinforced long and short-term terminal boiled heat polymerized and microwave-polymerized like in unreinforced groups[17].

MATERIAL AND METHODS

A. Heat cure base material: Heat cured acrylic (Densply, Stellon QC-20 England) used to make 80 plates of dimensions (50x5x2mm) length x width x depth respectively. A 40 plates represented the control which is the denture base materials without SGF, and 40 plates represented the test which is denture base materials with (2mm length, 2wt%) randomly oriented SGF[18]. The required length of fibers was obtained by using cutter. An electronic balance with accuracy(0.000lg) was used to weigh the fibers to the required weight needed for each specimen groups .Mixing procedure of fibers with the heat cured acrylic was conducted by adding the fiber to the powder using the mortar and pistil, the heat cured acrylic was mixed in a ratio used in this study (7.5mg/4ml) powder/ liquid) ratio, brass plate of dimensions (50x5x2mm) length x width x depth respectively which was used in silicon impression for fabrication the acrylic specimens, the dough acrylic moulded using silicon-stone mould[19] and cured using short curing cycle(90min at 74C° followed by 30 min at100C°)[20]

B. Light cure base material: light cured (Megadent) Germany were used to make 80 plates of dimensions (50x5x2mm) length x width x depth respectively. Like the heat cure acrylic a 40 plates represented the control which is the denture base materials without SGF, and 40 plates represented the test which is denture base materials with (2mm length, 2wt%) randomly oriented SGF. Mixing procedure of fibers with the light-cured material was performed by hand and the weighted fibers gradually added with continuing knead till getting homogenous materials. Special mould of clear glass was made of 2mm thickness and had 4slits, each slit of 50mm length and 5mm width(the same dimension as in heat cure group) The specimens were polymerized in the light-cure unit for 4min (according to the manufacturer's instruction). another 4min curing for complete polymerization

Specimens of both heat and light cure were finished and stored in distal water as the conventional method used for complete denture fabrication till the evaluation times for the amount of residual monomer at 3days, 7days, 14days, 30days. At the end of each immersion time the specimen were removed and drilled at low velocity prosthetic engine[10,6], 0.5g drill cutting collected in test tube dissolved in 10% High performance liquid chromatography HPLC grade 99.8% methanol alcohol as extraction solvent[7], for 4 days[21] then analysis of the amount of residual monomer has been done with the aid of HPLC (LC-20l0A HT Shimadzu Japan system equipped with ODS C18 column (250x0.4mm). Sample solution was injected and analyzed at room temperature at a flow rate 0.5ml/min).

Statistical methods

Suitable statistical methods were used in order to analyze and assess the results. They include the followings summary statistics of the readings distribution (mean, standard deviation SD), Student test (t-test)& the comparison of significant (P-value) ($P \leq 0.05$)

RESULTS

In Table-1, it was cleared that the highest mean values are (1.348) and (1.1543) that were obtained from unreinforced and reinforced heat cured resin groups respectively after 3days, while the lowest mean values are(0.2771)and(0.2248) were observed in unreinforced and reinforced groups respectively after 30days. Also this table shows that there is a significant difference between unreinforced and reinforced groups($P \leq 0.05$) after 3days only, while the difference between the unreinforced and reinforced groups in the amount of residual monomer after the (7, 14, and30)days are not significant ($P \geq 0.05$).

In Table2, shows the highest mean values (0.3913) and (0.16075) were obtained from measuring the residual monomer content in unreinforced and reinforced light cured resin groups respectively after 3 days of waiting in ringer solution. While residual monomer measurement after 30days, it was observed that the lowest mean values are (5.30E-03) and (4.56E-03) for unreinforced and reinforced groups respectively.

Also In this table, it is observed that there is none significant difference between reinforced and

unreinforced groups of light cured resin groups at all periods of time examined (P ≥0.05),except after 3days of residual monomer measurement, the result was a highly significant difference between reinforced and unreinforced groups of light-cured resin specimens examined (P≤0.01).

Table 1and Table2 illustrated the mean values in percentage &standard deviations of the amount of residual monomer content in heat &light cured acrylic resin groups with& without SGF at four periods of time also showed the statistical analysis was performed using student t-test. This test shows the comparative significant difference between SGF reinforced groups and unreinforced groups of both heat-cured & light cured resins

In Table3 Student t-test for comparison the amount of residual monomer content between heat and light-cured resin both (reinforced & unreinforced) groups that there is a highly significant difference(P≤0.01) in residual monomer content between heat and light–cured acrylic denture base materials (reinforced & unreinforced) groups for all periods of time conducted in this study except after 7 days between unreinforced groups of both heat and light cured resin the results was significant (P≤0.05).

Table1: Mean, Standard deviation& T-test for heat cured acrylic resin

Time	Groups	NO	Mean%	SD	Groups	P-value	Sig.
3 days	H	5	1.348	0.26498	H-H2%	0.011	S
	H2%	5	1.154	6.7689E-02			
7 days	H	5	0.369	0.13276	H-H2%	0.780	NS
	H2%	5	0.349	5.4834E-02			
14 days	H	5	0.274	4.1782E-02	H-H2%	0.978	NS
	H2%	5	0.272	3.0327E-02			
30 days	H	5	0.277	5.9301E-02	H-H2%	0.469	NS
	H2%	5	0.224	1.9766E-02			

H2%=heat cured specimens reinforced with 2%SGF
H=heat cured specimens without SGF

Table 2: Mean, Standard deviation& T-test for light cured acrylic resin

Time	Groups	No	Mean%	SD	Groups	P-value	Sig
3 days	L	5	0.391	0.24629	L-L2%	.000	HS
	L2%	5	0.160	6.115E-02			
7 days	L	5	0.132	3.1707E-02	L-L2%	.457	NS
	L2%	5	8.94E-02	3.0108E-02			
14 days	L	5	3.10E-02	6.8519E-03	L-L2%	.987	NS
	L2%	5	3.01E-02	5.3572E-03			
30 days	T	5	5.30E-03	4.1231E-04	L-L2%	.990	NS
	L2%	5	4.56E-03	1.0644E-03			

L=light cured specimens without SGF
L2%=light cured specimens reinforced with 2%SGF

Table3: T-test for comparison between mean values of residual monomer (heat& light) resins percentage

Time	Groups	p-value	Sig
3days	H- L	.000	HS
	H2% - L2%	.000	HS
7days	H- L	.011	S
	H2%-L2%	.000	HS
14days	H- L	.009	HS
	H2% - L2%	.000	HS
30days	H- L	.004	HS
	H2% - L2%	.000	HS

H= heat cured specimens without SGF
H2%= heat cured specimens with 2%SGF
L=light cured specimens without SGF
L2%=light cured specimens reinforced with 2%SGF

DISCUSSION

The residual monomer content of dental acrylic resins has continuing interest, this is due to its cytotoxic effect and tissue reactions. Furthermore, its negative influence on the mechanical properties may adversely affect the clinical performance of the removable denture [5].

There are different types of fibers according to their length and direction but, the use of short cutting randomly oriented SGF in denture base found to be simple technique [22, 18]. Also, the use of 2mm length SGF and 2% by weight was proved to improve the mechanical properties of heat cured acrylic [18].

In this study the powder / liquid ratio was used 7.56g/4ml for all specimens of heat-cured resin groups. This higher monomer ratio was used for good impregnation of GF in the polymer. The use of HPLC analysis was suitable for determining the amount residual monomer in denture base acrylic resin [12] Provides accurate estimation of the level of residual monomer in acrylic resins. This technique is a non destructive method of analysis which does not modify the specimen in the liquid at room temperature. Thus, eliminate heat and yield more accurate results [23]. In case of heat cured resin the results showed that were lesser residual monomer in SGF reinforced groups in comparison with unreinforced groups for all periods of time conducted in this study, this might be due to the presence of SGF in the acrylic resin specimens which lead to decrease the amount of polymer in comparison to the specimens without SGF since the powder/liquid ratio was standardized for both reinforced and unreinforced specimens.

These results in agreement with some authors [17] While others supposed that the addition of GF increase the amount of the residual monomer in heat cured resin significantly such results may be due to the methodology that conducted in the specimens preparation in this study which used continuous GF type So the problem of GF impregnation was solved by lowering the viscosity of the polymer by increasing the amount of liquid (monomer).the more monomer added to the mixture, the greater the amount of residual monomer[24]

In case of light cured resin the results revealed that the percentage of mean values of the amount of residual monomer in reinforced groups were lower than in unreinforced group. These results agreed with[25]who suggested that the addition of GF to the composite enhances the degree of conversion and decrease the leached residual monomers. It was seemed that the addition of GF aid in light transmission and light scattering in composite resin, as it was clear that the addition of GF did not increase the amount of residual monomer. From the results, it was appeared that the mean values of residual monomer in heat-cured was significantly higher than light-cured resin. Such results agreed with [26, 27] and disagreed with [28] who reported that light-cured acrylic is free of residual monomer. The lower mean values of residual monomer in light-cured resin may be due to that the material is partially polymerized as the polymer / monomer ratio was prepared by the manufacturer's machine, also the presence of other constituents other than MMA that respond to light for complete polymerization. Both types of acrylic denture showed decrease the amount of residual monomer with increasing time as shown in previous study [11].

The Addition of silanated glass fiber slightly reduces the amount of residual monomer in heat-cured and light-cured denture base materials. Also the amount of residual monomer of both types of denture base materials decreased with time increased.

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