The Effect of Different Types of Separating Medium On The Hardness of Different Types of Heat-Cure Acrylic Resin Materials

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Abstract

In the present study evaluation of the effect of different types of separating medium on the hardness of hot-cure acrylic resin material cured by water path conventional method and microwave curing method .Forty specimens of hot-cure acrylic resin were fabricated in order to provide an standardized dimensions of tested specimens (65mmx50mmx2.5 ±0.03mm) length, width and depth respectively· these specimens were invested by either cold mold seal or glycerin separating medium ·

(40) specimens were used in this study, divided into four main groups according to the type of separating medium and curing technique used (ten specimen for each group);were as follows:

Group A: Specimens lining with cold mold seal separating medium (C·M·S)(control group) cured by water bath device·

Group B: Specimens lining with glycerin separating medium (G) cured by water bath device·

Group C: Specimen lining with cold mold seal separating medium (C·M·S) cured by microwave device·

Group D: Specimens lining with glycerin separating medium (G) cured by microwave device·

The result of this study indicated a significant difference between groups($p<0.05$) in ANOVA test and heat-cure acrylic cured by water bath that lining with glycerin have a high mean value in comparison to another tested groups and heat-cure acrylic cured by microwave that lining with glycerin have a lower mean value in comparison to another tested groups .

From this study we can concluded that glycerin is safely separating medium that can be used in dental laboratory because it is less cost and gives good mechanical properties when used with acrylic denture base materials.

Also we can conclude that the type of packing or curing method affects the hardness of heat-cure acrylic resin.

الخلاصة

في الدراسة الحالية تم استخدام نوعين مختلفين من الوسيط العازل لتأثير قوة الصلادة لمادة (الاكريلك الحار) المعالج في طريقتي طبخ مختلفتين وهي بخار الماء التقليدي والطبخ بالمايكروويف الحراري . تم جمع أربعون عينة مربعة الشكل من الاكريلك الحار المعالج لغرض توفير أبعاد قياسية لأنواع(مفحوصة ذات طول وعرض وسمك) (65mmx50mmx2.5±0.03mm) هذه المربعات يتم تغميسها إما في الوسيط العازل(C.M.S) أو (G.) هذه الأنواع الأربعون تم تقسيمها إلى اربع مجموعات رئيسية حسب نوع الوسيط العازل المستخدم و حسب نوع جهاز الطبخ المستخدم (١٠عينات لكل مجموعة رئيسية) كما يلي : المجموعة الأولى (A): أنواع مبطنة بوسيط عازل (Cold mold seal) طبخت العينات الاكريليكة باستخدام بخار الماء و المجموعة الثانية(B): أنواع مبطنة بوسيط عازل (Glycerin) طبخت العينات الاكريليكة باستخدام بخار الماء والمجموعة الثالثة (C): أنواع مبطنة بوسيط عازل (Cold mold seal) طبخت العينات الاكريليكة باستخدام المايكروويف اما المجموعة الرابعة (D): أنواع مبطنة بوسيط عازل (Glycerin)طبخت العينات الاكريليكة باستخدام المايكروويف.

أظهرت النتائج في هذه الدراسة بان الكليسيرين هو أفضل مادة عازلة مستخدمة نتيجة لأفضل النتائج في فحص الصلادة التي تم الحصول عليها عند استخدام صوديوم ختم القالب كمادة عازلة للمجموعة القياسية علاوة على ذلك ليس هناك أي تغير في التركيب الكيميائي لعينات الراتنج الاكريلي المبلمر الحار بطريقتي الطبخ نتيجة لاستعمال الكليسيرين كمادة عازلة ولان مادة الكليسيرين سهلة الحصول والاستخدام ومتوفرة ورخيصة فأن استعمالها الراتنج الاكريلي المبلمر الحار كمادة عازلة يعطي نتائج افضل .

Introduction

The hot-cure PMMA is one of very important material in dentistry which is referred to as acrylic resin has been introduced for using in dentistry since the early1930. Acrylic resin become the most reliable material for denture construction (denture base, reline , rebase, orthodontic appliance and crown and bridge work as a maxillofacial prosthesis) so that it is necessary to know it is properties characterized effects and all factors which effect these materials to produce these results(prosthesis)**[1 and 2]**.

Separating media are materials used for filling porous surface to effect easy separation of other materials which are later poured against them **[3 and 4]** Therefore the acrylic resin must be carefully protected during processing from the gypsum surface in the mould spaces for two reasons:

1-Any water incorporate in to the resin from the gypsum during processing will defined affect the polymerization rate and the cold of the resin: the denture procedure will craze readily of water after the processing: particularly if the resin is not cross-linked.

2-Dissolved polymer and free monomer must be prevented from soaking in to the investing medium, portions of gypsum material will be joined to the denture after polymerization: with result that it will be virtually impossible to separate the investing material from the resin **[5 and 6]**.

Materials and Methods

Instrument and Equipment:

1-Wax knife.

2- Finishing burs (acrylic ;stone ;fissure and sand paper).

3-Prosthetic hand piece (wand Heleo ,Austria).

4-Metal mold .

5-Brinell hardness Device (Hydraulyic press, Leybold Harris CO.,British) .

6-Water bath (Derotor ,Quayle Dental QD.,England).

7-Microwave oven (Universal Micro. Oven, WP 1000 AL 17-3,China)

Materials

The materials used in this study are:

1- Pink heat-cure acrylic resin (Triplex hot Ivoclar vivadent ,Liechtenstein)

2-Dental stone (Type 3 model dental stone ,Elite model ,Italy).

3-Dental pumice (Steribim plus ,Germany).

4-Distilled water (AL-Mansore Co., Iraq).

5-Separating medium.

The Separating media used in this study are:

Table (1): Types of separating media used in this study

Types of separating medium	Trade name	Manufacturer	Specification

Cold-Mold Seal	P.D Pink colour 11b separating film	Switzerland	Produits Dentaires S.A807317
Trihydroxy alcohol	Glycerin	Malaysia	(2,7323-M)

*P.D= Produits Dentaires

Methods

Samples preparation

A rectangular metal pattern was prepared with the dimensions of (65mmx50mmx2.5 ±0.03mm) length, width and depth, respectively Figure (1). (40) Samples of heat cure acrylic resins cured by (water bath and microwave) device. (10 specimens for each type of curing the acrylic denture base resin) and (10) for each type of separating medium used in these study that (glycerin and cold mold seal).

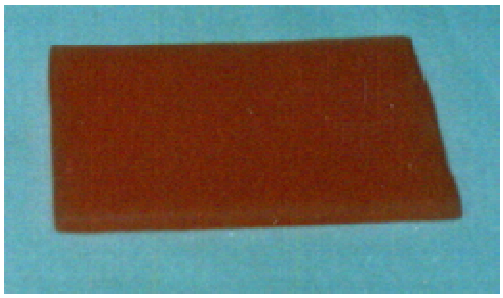

Figure (1): Specimens of hardness the acrylic denture base.

Mold Preparation

During preparation of the mold, the conventional flasking technique was followed. The lower portion of the dental flask was filled with dental stone mixed according to the manufacturer instructions (i.e. W/P ratio is 25ml/100g); layer of stone mix was placed on metal block to avoid trapping of air when inserting the metal block into the stone mix after coating with separating media. After stone was set, both the stone and metal patterns were coated with separating media Figure (2).The upper half of the flask was then positioned on top of lower portion and filled stone, with vibration to get rid of the trapped air. Stone was allowed to harden for 60 minutes before the flask was opened .The metal patterns were invested each time when the samples were to be prepared. The flask was then opened and metal patterns were removed from the mold carefully .In case of using cold –mold seal and Glycerin separating medium, (2cc) of Glycerin was measured by using a disposable syringe and applied onto the stone surface in the flask, with a fine brush (No.0) **[7] .**

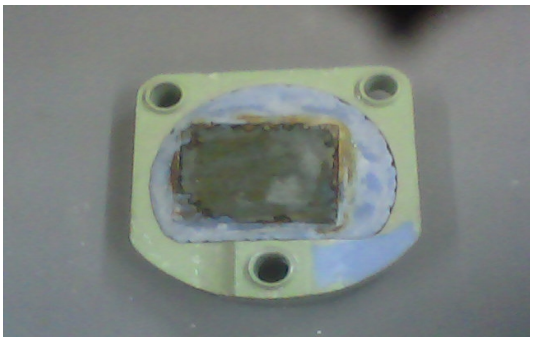

Figure (2): Metal specimens of hardness in the flask.

Preparation and Mixing of heat-cure acrylic resin

Pink heat cured acrylic was mixed according to manufacturer's instructions (3:1) by volume. The pink cold-cured acrylic was mixed also according to manufacturer's instructions (2.5:1) by volume. The liquid was placed in a clean dry mixing vessel followed by slow addition of powder. The mixture was then stirred with wax knife and left to stand in a closed container at room temperature until reaching the dough stage.

Packing of heat-cure acrylic resin

The packing process was performed while the acrylic is in dough stage. The resin was removed from its mixing jar and rolled, then packed into the mold previously coated with separating media with the aid of polyethylene sheet. The two halves of the flask were closed together and placed under the hydraulic press (1200 psi), and then the pressure was slowly applied to allow even flow of the dough throughout the mold space. The pressure was then released; the flask was opened and removed with wax knife. A second trial closure was performed, the stone surface the over flowed material (flash) surrounding the mold space was again coated with the separating media, allowed to dry and the polyethylene sheet was removed .The two halves of the flask were finally closed until an intimate contact had been established and left under the press (1200 psi) for 5 minutes then the flask was placed in a flask clamp thus maintaining un disturbed pressure during processing.

Curing in water bath method

Curing was carried out by placing the clamped flask in a water bath and processed by heating at 74^0C for about an hour and half .The temperature was then increased to the boiling point for 30 minutes according to **[8]**. After completing the curing, the flask was allowed to cool slowly at room temperature for 30 minutes. Followed by, complete cooling of the flask with tap water for 15 minutes before deflasking. The acrylic patterns were then removed from the mold.

Curing in microwave method

A microwave –cured acrylic resin (Acorn TM MC), was used to make the samples in this study following the manufacturer's instructions. A mix of 30 cc of powder and 9 cc of liquid was prepared and left to reach the dough phase at room temperature (approximately 23^0C). After filling the molds with the dough, the flasks were fitted and pressed together in a hydraulic bench press for 30 minutes before polymerization selected. Microwave energy device is used in this study for polymerization of PMMA resin, the short cycle was 500 watts for 3 minutes, left for 30 minutes then quenched in cold running tap water for 15 minutes **[9].**

Finishing & Polishing

An acrylic bur was used to remove all flashes of acrylic followed by 120-grain size sand paper with continuator term-cooling (to prevent over heating) in order to get smooth face (except the samples that are used for surface roughness). Polishing was accomplished using bristle brush and wheel with pumice using dental lathe polishing man (low seed, 1500 rpm) till glossy surface was obtained , mal measurements of the samples were obtained using fernier.

Hardness test

A- Test Specimen

Acrylic resin specimens were prepared as described previously .The final dimensioning were (65x50x2.5mm).

B-Test equipment & procedures

Shore hardness tester was used in this study for measuring the indentation hardness of the specimens the test load was set to50 N for share (D) which is suitable for acrylic resin material Figure (4).The contact surface of the shore hardness tester must be parallel to the specimen support of the test stand to prevent errors in measurements .The distance between the specimen surface and the indenter of the hardness tester was set be 5-12 mm. During carrying out the test the contact period between the specimen and the indenter was 6 seconds. After that the measurements were taken directly from the scale reading .Five measurements were done on different area of each specimen and the average of five readings was calculated. **[10]**

Figure (4): Shore hardness tester

Result

The mean and standard deviation and one way ANOVA and t-test of five reading for each specimen's test of shore hardness of different types of separating medium cured by two-methods that water path and microwave device and the average of these reading were calculated and listed in table (2). Result of this study indicated that the hot –cure acrylic denture base lining with Glycerin and cured by water path device. In Group (B) showed the highest mean values of shore hardness (81, 81) .While the lowest hardness resistance are showed in group (D) that hot –cure acrylic lining with Glycerin cured by microwave device (79, 71).

Table (2): Mean, standard deviation of shore hardness value of tested group and control group. Analysis of variance ANOA test when applied between groups revealed a statistically.

Table (2): Mean, standard deviation of shore hardness of different types of lining material.

Statics	Control group A	Group B	Group C	Group D
Min	79,5	79,5	78,5	78,5
Max	81,6	85,5	81,6	81,5
Mean	80,51	81,81	80,03	79,71
SD±	0,955045	2,212314	1,086329	1,031127
SE	0,302229	0,700099	0,343775	0,326306

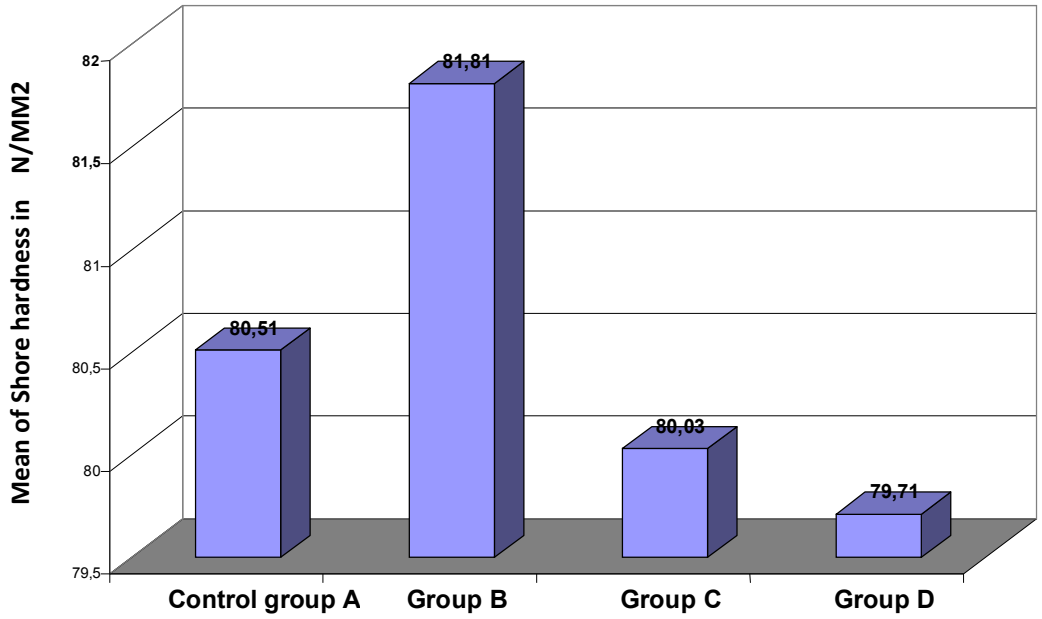

Figure (5): Histogram of shore hardness with mean values of the control and tested groups.

Table (3) show the ANOVA test represents the significant difference result of the all tested groups.

Table (3): ANOVA analysis of variance test of shore hardness between tested groups.

	F-test	P-value	Sig
Between groups	3.973	0.0182	S

***P<0.05 Significant**

In Table (4): Show the t-test of tested groups with comparison between them which included that group (A) and (B), (C), (D) groups indicated no significant difference between than while the group (B) and groups (C) and group (D) indicated significant differences between them.

Table (4): t-test for comparison between Control and tested groups.

	t-test	P-value	Sig
Control&Group A B	1.812	0.103	NS
Control&Group A C	0.877	0.403	NS
Control&Group A D	1.385	0.199	NS
Group&Group B C	2.399	0.040	S
Group&Group B D	2.180	0.035	S
Group&Group C D	0.794	0.448	NS

***P<0.05 Significant**

****P>0.05 Non significant**

Discussion

Hardness is a term used to describe the resistance of shore hardness as distinct from resistance to wear or scratching [**11**].

Among other factors coefficients, separating medium must be used, due to its effect on the physical and mechanical properties of the processed acrylic denture base materials.

The result of shore hardness of this study indicated the high values of

hardness was obtained in heat – cured acrylic resin processed against Glycerin separating media when compared with those samples processed against cold – mold seal separating media, in **Table (2), Figure (5)** the result indicated that group (B) hot cure acrylic lining with glycerin and cured by water path showed the highest mean value of shore hardness while the lowest hardness resistance are showed in group (D) that hot cure acrylic lining with glycerin and cured by microwave. This result may be due to the differences in curing methods and method of polymerization of acrylic denture base that water path method is preferred method of curing which gives the best result in hardness .this result agreement with [**12, 13 and 14**].

ln general, heat-cured material cured by water path is significantly harder than heat-cured material cured by microwave under all conditions. This could be related to the higher amount of residual monomer presented in heat-cured type cured by microwave which adversely affects the shore hardness. And glycerin separating media show a comparable result concerning in shore hardness. This result agreement with [**15, 16 and 17**].

From **Table (3)**, used ANOVA test showed a statistically significant difference between samples processed against cold-mold seal separating

medium and those samples processed against glycerin separating medium. While in **Table (4)**, used t-test there was a non significant difference between samples processed against glycerin and cold-mold seal separating media control group. This could be related to high water sorption which leads to greatest decrease in shore hardness. This explanation is in agreement with [**18**]. Their findings were confirmed by **[19 and 20**] when they reported that water sorption adversely affects the hardness resistance of PMMA. Also it may be related to porosity, which may decrease the hardness resistance. This result agreement with result of [**21, 22 and 23]**

From the results obtained it can be concluded that glycerin can be used safely as a separating medium for acrylic denture base resin. **[24]**

Conclusion

1-Glycerin is the best type of separating medium to gives the highly hardness in comparison to cold-mold seal separating medium.

2-Heat –cure acrylic lining with glycerin and cured with water bath give the highly hardness in comparison to heat –cure acrylic lining with cold-mold seal and cured by micro wave device.

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