تأثير درجه الحراره المرتفعه على قوه الشد لقاعده الطقم ذات الاكريلك(الراتنج) البارد بلمقارنه مع الاكريلك الحار

Effect of The Elevated Temperature on the Tensile Strength of Cold Cured Acrylic Denture Base in Comparison to Heat Cure Acrylic

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ABSTRACT

Acrylic denture base materials were possessing adequate mechanical strength to with stand the load of mastication. The strength properties of cold cured is lower than that of the heat cured**.** Studies were done to increase the strength of cold acrylic resin. The purpose of this study was to evaluate the tensile strength of cold cured when polymerized by elevated temperature and compare to those polymerized by conventional methods also to compare it with heat cured acrylic polymerized by the same methods.

Sixty specimens, thirty from cold cured acrylic and thirty from heat cured acrylic were prepared, flasking and packing procedure were done according to manufacturer direction and divided according to polymerization as follow:20 specimens(10 from cold cured and 10from heat cured acrylic)were polymerized by ivomat curing device containing water under air pressure 30 Pascal for 15 minutes at37˚C. 20 specimens (10 from cold cured and 10from heat cured acrylic) were polymerized by microwave oven; the power level was set at 50% to get 500 watts output for 3 minute and 20 specimens (10 from cold cured and 10from heat cured acrylic)were polymerized by water bath (fast cycle).All specimens were tested for tensile strength.

Result showed that the cold cured acrylic have high value of tensile strength when processed by elevated temperature (by water bath and microwave) in comparison to those processed by conventional methods (Ivomate)with highly significant differences $P<0.01$, There was no significant differences $P=0.11$ between cold cured acrylic groups that polymerized by water bath and heat acrylic groups that polymerized by microwave. Heat cured acrylic that polymerized by water bath show the maximum value for tensile strength followed by heat cured acrylic that polymerized by microwave, then by cold cured acrylic groups that polymerized by water bath ,while the least group for the tensile strength recorded by heat cured acrylic that polymerized by Ivomate. Also show there was significant and highly significant differences between all groups (cold and heat cured acrylic) processed by three methods (Ivomate, water bath, microwave).

ألخلاصه

الاكريلك الراتنجي لماده قاعده الطقم يتحمل قوة ميكانيكية كافية ليقاوم ضغط المضغ خصائص القوة للاكريلك البارد هي اقل من الاكريلك الحار الدراسات اجريت لزيادة قوة الاكريلك البارد.ان الهدف من هذه الدراسه لتقييم قوه الشد للاكريلك البارد عند بلمرته بواسطه درجات حراره عاليه ومقارنته بلمتبلمر بلطريقه الاعتياديه باستخدام جهازIvomate ومقارنته ايظا بالاكريلك الحار اللمتبلمر ينفس الطرق .

60عينه,30من الاكريلك البارد و30من الاكريلك الحار حضرت ووضعت في البودقه طبقا لتعليمات الصنع وقسمت الى مجاميع

حسب البلمره ,20عينه (10من الاكريلك الحار و من الاكريلك البارد10)بلمرت بواسطه جهازIvomate تحت ضغط حراري30باسكال/انج^{2}لمده 15دقيقه بدرجه°37سيليليزيه و20عينه (10من الاكريلك الحار و من الاكريلك البارد10)بلمرت بواسطه المايكروويف تحت مستوى طاقه50%,500واط لمده3دقائق,و و20عينه (10من الاكريلك الحار و من الاكريلك البارد10)بلمرت بواسطه الحمام المائي(الطريقه السريعه).جميع العينات خضعت لاختبار قوه الشد.
اضهرت النتائج بأن الاكريلك البارد الذي بلمر تحت بدرجات حراره مرتفعه (بواسطه الحمام المائي و المايكروويف) يمتلك قيمه اعلى لقوه الشد مقارنه مع الاكريلك البارد المتبلمر بلطريقه الاعتياديه باستخدام جهازIvomate وبفروق معنويه عاليه0,01 >P,ولاتوجد فروق معنويه P= 0,11 بين مجموعه الاكريلك البارد الذي بلمر بواسطه الحمام المائي مع الاكريلك الحار الذي بلمر بواسطه المايكروويف.
الاكريلك الحار الذي بلمر بواسطه الحمام المائي سجل اعلى قيمه لقوه الشد تلي بالاكريلك الحار الذي بلمر بواسطه المايكروويف ,ثم تلي بالاكريلك البارد الذي بلمر بواسطه الحمام المائي بينما سجل الاكريلك الحارالذي بلمر بواسطه جهاز Ivomate اقل قيمه لقوه الشد.ايظا اظهرت النتائج بأن هناك فروق معنويه وفروق معنويه عاليه بين جميع المجاميع المتبلمره بطرق الثلاثه (Ivomate ,المايكروويف ,الحمام المائي)

INTRODUCTION

Acrylic resin denture base was introduced as denture base materials in the early 1930[1] , acrylic resin used mainly for denture construction[2]because acrylic denture base materials was possessing of adequate mechanical strength to with stand the load of mastication [3,4,5].

The advantages for using cold-cured acrylic resin in prosthetic work is mainly due to simple technique at room temperature, less time consuming and less equipment required[6]. Cold-cured acrylic resin are basically the same as the heat-cured acrylic resin denture base, varying only in the manner in which polymerization is initiated at room temperature [7,8]. The degree of polymerization of cold cure resin is not as complete as that achieved by using heat cure system so the strength properties of cold cured is lower than that of the heat cured[1,9] .

Heat activated acrylic are used in the fabrication of nearly all denture bases. Water bath polymerization is the commonest and widely used method for denture processing [2,9].

Acrylic resin may also be polymerized by using microwave energy which was first reported by Nishii,1968[10].The major advantage of this technique is the speed with which polymerization may be accomplished, further more, the physical properties and the fit of the denture bases polymerized by using microwave energy are comparable with those processed by conventional technique [8,11].

Although the heat activate the chemical reaction of acrylic resin and improved its properties, there were visa versa in studies that polymerized the cold cured acrylic under pressure and elevated temperature, study found that there were no significant changes in the strength of the chemically activated acrylic resin when polymerized under pressure and elevated temperature[12] ,other observed little improvement in strength of the chemically activated acrylic resin when polymerized under water at15,30&60Ib/in^2 pressure compared with those prepared under room condition and when processed under high temperature [13,14]. So this study was conduced to evaluate the tensile strength of cold cure acrylic resin when polymerized by elevated temperature {water bath procedure and microwave procedure}and compared to those polymerized conventionally by Ivomate, also to compare it with heat cure acrylic polymerized by the same methods.

MATERIALS AND METHODS

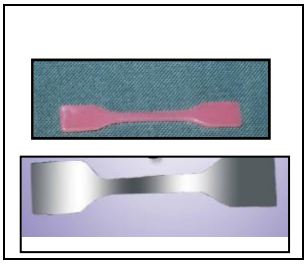
Table (1) show the materials that used in the study.

Table (1): Materials used in the study.

Batch number	Manufacturer	Trade name	Type of material
ISO 1567, Type II, class I ADA no.12	Italy	Major repair 2	Pink cold-cure acrylic resin
Quality registed ISO 9002	Zhermack SPA-45021 Badia Polesine Italy	Elite Stone	Dental stone
Produits dentaires S.A 807317	Switzerlada	PD pink colour 1Ib separating film	Separating medium
Dental trade distribution	England	Amalgamated "Trevalon"	Polythene separating sheets
Corporation 361, Louisville, Kentucky 40217	U.S.A	Grade CL125 fine	Pumice
----	Iraq	Al-Mansore com.	Distilled water
------	Italy type	Major base	Hot cure acrylic resin

Preparation of mould

60 specimens from dumbbells shaped metal pattern were prepared30 specimens from cold acrylic and 30 specimens from heat acrylic were prepared with dimension of (75mm, 12.75mm, 2.50-+0.03mm) length, width and depth respectively as shown in figure(1) .This study was done in (May-2010) in the College of Health and Medical Technologies and the measuring of the tensile strength was figure(1) done in the University of Technology.



Methods:

The conventional flasking ,packing procedures were followed in the preparation of the specimens .

Polymerization

20 specimens(10 from cold cured and 10 from heat cured acrylic)were polymerized by Ivomat In case of using Ivomat ,flask with acrylic resin dough were transferred for curing in the Ivomat curing device containing water under air pressure 30 psi for 15 minutes at37˚C(ADAS, No. 12, 1975)[15].

20 specimens(10 from cold cured and 10from heat cured acrylic)were polymerized by microwave, by placing the flask in microwave oven .The power level was set at 50% to get 500 watts output for 3 minute.

20 specimens(10 from cold cured and 10 from heat cured acrylic)were polymerized by water bath (fast procedure), polymerization was carried out in case of water bath by placing the clamped flask in water bath and processed by heating at 74 ˚C for 1,1/2 an hour and the temperature was then increased to the boiling point for half an hour according to (ADAS, No 12, 1999)[16].

After completion and curing the acrylic specimens were removed carefully from the stone mold. All the acrylic resin specimens were finished and polished according to conventional procedure till glossy surface was obtained. The final measurements were obtained using the micrometer and vernier.

Distribution of the sample

Acrylic resin denture base:
Heat acrylic resin denture base:
1-Group A: Heat acrylic resin denture base polymerized by water bath.(10 sample)
2-Group B: Heat acrylic resin denture base polymerized by microwave. .(10 sample)
3-Group C: Heat acrylic resin denture base polymerized by Ivomate. .(10 sample)
Cold acrylic resin denture base
4-Group D: Cold acrylic resin denture base polymerized by Ivomate.(10 sample)
5- Group E: Cold acrylic resin denture base polymerized by microwave.(10 sample)
6- Group F: Cold acrylic resin denture base polymerized by water bath .(10 sample)
Methods of evaluation
The tensile strength was tested using instron testing machine equipped with grips suitable for holding the test specimen. Set at across head speed of 0.5mm/min, with achart speed 20mm/min. The load was measured by a tensile load cell with a maximum capacity (200 Kg).The recorded force at failure was measured(Kg) which were converted into(N)(Abu-Anzeh, 2003)[17]. The values of tensile strength were calculated by the following formula (Graig and Powers, 2002)[18].

$$T.S.\frac{F}{A}$$

Where: T.S. = Tensile strength (N/mm).
F. = Force at failure (N).
A = Area of cross section at failure (mm).

Results

Table(1) show the Descriptive of groups : mean, SD.min , max values of the tensile strength of all six groups.

Cold cured acrylic have more value of tensile strength when polymerized by elevated temperature (by water bath GroupF and microwave GroupE) in comparison to those processed by conventional methods(Ivomate GroupD)

Group A{heat acrylic that curing by water bath}show the max value for tensile strength which was 76.31 followed by Group B{ heat acrylic that polymerized by microwave} which was equal to 73.71,then by Group F(cold cured acrylic groups that polymerized by water bath) which was 72,65 while the least group for the tensile strength recorded by Group C{ heat acrylic that polymerized by Ivomate} which was equal to 59.88 .

Figure 2 show the hectograph of the mean of the tensile strength for the six groups**.**

Table(1) Descriptive of groups

	A	B	C	D	E	F
Mean	76,31	73,71	59,88	68,11	70,97	72,65
SD	1,159	1,578	0,880	0,669	0,930	1,179
Max	77,75	75,38	61,11	69,25	73,04	74,12
Min	74,63	70,86	58,22	67,3	69,97	70,86

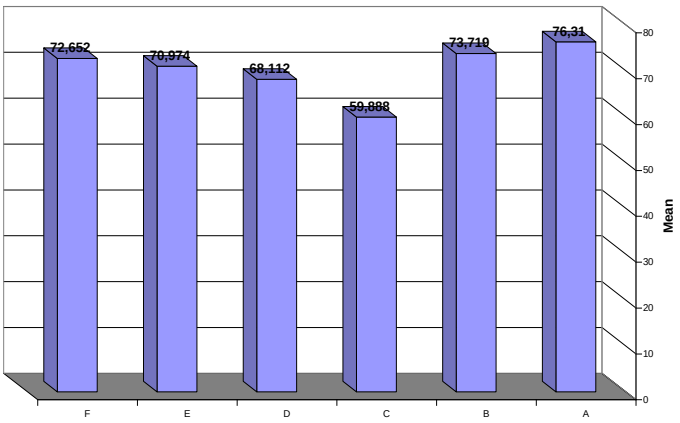


Figure 2 Hectograph mean of the tensile strength for the six groups**.**

Table (2) show the ANOVA significance between these groups:

1- ANOVA between heat cured acrylic groups that polymerized by three methods: A(water bath), B(microwave) ,C(Ivomate) ,there was highly significant between them P<0.01 .
2- ANOVA between cold cured acrylic groups that polymerized by three methods: D(Ivomate), E(microwave) ,F(water bath) ,there was highly significant between them P<0.01 .
3- ANOVA between three groups which considered as a control methods for polymerization: A(heat cured acrylic groups that polymerized by water bath), B(heat polymerized acrylic groups that polymerized by microwave)these two groups represent the control methods for curing heat cured acrylic, while group D(cold cured acrylic groups that polymerized by Ivomate) represent the control methods for curing cold cured acrylic, there was highly significant between them P<0.01 .
4- ANOVA between all six groups(heat cured acrylic and cold cured acrylic)that polymerized by different methods there was highly significant between them P<0.01 .
5-

Table(2) ANOVA between groups

		F-test	P-value	Sig
1	A,B,C	507.35	P<0.01	HS
2	D,E,F	58.46	P<0.01	HS
3	A,B,D	123.1	P<0.01	HS
4	A,B,C,D,E,F	274.1	P<0.01	HS

**High significant difference*

Table(3) show the LSD between six groups ,there was highly significant between them P<0.01 as illustrated by this table, except that between group A(heat cured acrylic groups that polymerized by water bath)and B(heat cured acrylic groups that polymerized by microwave) , group B(heat cured acrylic groups that polymerized by microwave) with group E(cold cured acrylic groups that polymerized by microwave), and between group F(cold cured acrylic groups that polymerized by water bath) and group E(cold cured acrylic groups that polymerized by microwave) there was significant differences between them P<0.05 .

There was no significant differences P=0.11 between group B(heat cured acrylic groups that polymerized by microwave) and group F(cold cured acrylic groups that polymerized by water bath)

Table (3) LSD between all groups

Groups	P-value	Sig
A&B	0.007	S
A&C	P<0.01	HS
B&C	P<0.01	HS
D&E	P<0.01	HS
D&F	P<0.01	HS
F&E	0.023	S
A&D	P<0.01	HS
B&D	P<0.01	HS
A&E	P<0.01	HS
A&F	P<0.01	HS
B&E	0.003	S
B&F	0.11	NS
C&D	P<0.01	HS
C&E	P<0.01	HS
C&F	P<0.01	HS

*P<0.05 Significant
**P>0.05 Non significant
***P<0.01 High significant

Discussion

The result show that the tensile strength of cold cure acrylic when processed by three methods were lower to heat cure acrylic that processed by water bath and microwave this due to the degree of polymerization of cold cure resin is not as complete as that achieved by using heat cure system, thus lead to high degree of residual monomer that act to lowering the strength of acrylic resin, this result agree with Ruter and Sevedson,1980[19] and Ray,1998[20]and others that show these un reacted monomer serves as a potential tissue irritant and act as plasticizer which result in lowering the strength properties of acrylic [21,22] .

The result show the maximum value for tensile strength recorded by Group A{heat acrylic that curing by water bath} which was 76.31 followed by Group B{ heat acrylic that curing by microwave} which was equal to 73.71,for the heat cured acrylic, the application of thermal energy will lead to the decomposition of initiator and production of free radicals which subsequently initiate polymerization ,then followed by Group F(cold cured acrylic groups that cured by water bath) which was 72,65,then by Group E{ cold cured acrylic groups that cured by microwave}, the cold cured acrylic have high value of tensile strength when processed by elevated temperature (by water bath and microwave) in comparison to those processed by conventional methods(Ivomate)with highly significant differences P<0.01, the tensile strength of cold cured acrylic will improved when cured by elevated temperature, this may be due to increasing in the time of polymerization and the methods of activation technique that used water ,the water for any type of polymerization technique in acrylic process dose always minimize the residual monomer that effect the strength of acrylic and because of increased time of exposure to heat which produce greater degree of conversion of monomer into polymer and less residual monomer level that may increase the tensile strength, this result with agreement with Ogawa,et,al 2000 [13]Leong and Grant1971[14], but disagree with McCroric and Anderson,1960[12] that found that there were no significant changes in the strength of the chemically activated acrylic resin when polymerized under pressure and elevated temperature .

The cold cure acrylic have lower value of tensile strength when processed by conventional methods(Ivomate) in comparison to those processed by elevated temperature (by water bath and microwave) with highly significant differences P<0.01,this might be due to high water sorption in specimens polymerized at lower temperature. Thus increasing the distance between the molecular chains which may lower the strength properties, this is in agreement with Davenport,(1972) [23]. Other explanation could be related to the presence of porosity in specimens cured at lower temperature. This agreed with studies [5,23,24] that found that if porosity found in acrylic, the strength will be lowered.

while the least group for the tensile strength recorded by Group C{ heat acrylic that curing by Ivomate} which was equal to 59.88 this may related to the polymerization reaction don't complete at lower temperature{failure of initiator to decompose and product of free radicals that initiate polymerization as mentioned and high degree of residual monomer that result in lowering the strength properties this was in agreement with Padmakar,et al 2009 [25] and Sherman, et al 2006[26].

Conclusion

1-The elevated temperature improve the tensile strength of cold cure acrylic. The cold cured acrylic have high value of tensile strength when processed by elevated temperature (by water bath and microwave) in comparison to those processed by conventional methods(Ivomate)with highly significant differences P<0.01.

2- The tensile strength of cold cured acrylic reaches approximately the tensile strength of heat cured acrylic when polymerized by elevated temperature. There was no significant differences P=0.11 between cold cured acrylic groups that polymerized by elevated temperature (water bath) 72,65 and heat cured acrylic groups that polymerized by microwave73,71.

3-Heat cured acrylic that polymerized by water bath show the maximum value for tensile strength followed by heat cured acrylic that polymerized by microwave, then by cold cured acrylic groups that polymerized by water bath.

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