Journal of Kerbala University , Vol. 7 No.4 Scientific . 2009

THE EFFECT OF TWO DIFFERENT PROCESSING TECHNIQUES (WATER BATH AND CHEMICAL POLYMERIZATION) ON THE TRANSVERSE STRENGTH OF COLD CURE ACRYLIC RESIN DENTURE BASE

م.م. سجى علي محسن ألشمري/ ماجستير تقنيات الاسنان
كلية التقنيات الصحية والطبية/ هيئة التعليم التقني

ABSTRACT

This study aimed at evaluating the transverse strength of cold cured acrylic resin denture base as an alternative material for heat cure acrylic resin denture base material when processed in water bath. 30 samples of (65mm length X 10mm width X 2.5mm thickness) were made for transverse strength test. There were 3 experimental groups, (n = 10 per group): G1) heat cure acrylic resin (fast way- water bath curing) as a control group; G2) cold cure acrylic resin (fast way- water bath curing); G3) cold cure acrylic resin (slow way- chemical curing). Transverse strength was assessed after specimens were completely cured, finished and polished. The results revealed that the cold cure acrylic specimens which processed in water bath at 74ºC for (1 ½ hr) then 100ºC for ½ hr have better transverse strength than cold cure acrylic which polymerized under hydraulic press for (2 hrs) in spite of the curing time equivalence .

الملخص //

تهدف هذه الدراسة إلى تقييم المتانة المستعرضة لقاعدة طقم الأسنان المصنوع من راتنجات الاكريليك البارد كمادة بديلة لراتنجات الاكريليك الحار بواسطة معالجتها داخل حمام مائي. ٣٠ عينة ذات الأبعاد (٦٥ ملم الطول × ١٠ ملم العرض× ٢.٥ ملم السُمك) قد تم تحضيرها لقياس المتانة المستعرضة لمادة الاكريليك الراتنجي . تم تقسيم العينات إلى ٣ مجاميع تجريبية (١٠ عينات لكل مجموعة).

G1: (راتنجات الاكريليك الحار /الطريقة السريعة: حمام مائي) ;

G٢: (راتنجات الاكريليك ألبارد /الطريقة السريعة: حمام مائي)

G٣: (راتنجات الاكريليك ألبارد /الطريقة البطيئة: بلمرة كيميائية)

المتانة المستعرضة للعينات تم قياسها بعد اكتمال التبلمر ، التشذيب و التلميع. أظهرت النتائج الإحصائية أن راتنجات الاكريليك ألبارد المتبلمر داخل حمام مائي عند الدرجة ٧٤ درجة سيليزية لمدة (١½) ساعة ثم ١٠٠ درجة سيليزية لمدة (½) ساعة تملك متانة مستعرضة أفضل من راتنجات الاكريليك ألبارد المتبلمر بصورة ذاتية تحت المكبس الهيدروليكي لمدة (٢ ساعة) بالرغم من أن التبلمر قد تم في وقت متساوٍ.

Introduction

Acrylic resin dentures are susceptible to fracture after clinical use; it is an unresolved problem in prosthodontics [1]. Among the desirable properties of the denture base material is the possession of adequate mechanical strength to withstand the load of mastication [2, 3]. Heat activated acrylic resin denture base are used in fabrication of nearly all denture bases, the application of thermal energy will lead to the decomposition of initiator and production of free radicals which will subsequently initiate polymerization [4]. Chemically activated acrylic resin are basically the same as the heat cured acrylic resin denture base materials, varying only in the manner in which polymerization is initiated at room temperature [5]. The degree of polymerization of cold cure acrylic resin is not as complete as that achieved by using heat cured system, this leads to higher degree of residual monomer [5, 6]. These unreacted monomers serves as a potential tissue irritant and act as plasticizer which results in higher

transverse deflection values and lower transverse strength [5, 7]. The chemically cured acrylic resin are generally about (0.1%) over size after several months of service while heat cured acrylic dentures are (0.3% to 0.4%) under size [8], and the transverse strength of cold cured resins is approximately 80% of the heat cured material, also it can be processed by the same compressing mould technique utilized for heat cured resin, these resins were found to produce durable and stable denture [9]. The heat cure resin that repairs with a heat cure resin are stronger than that repairs with cold cured resin but are more difficult to carryout and are more likely to cause dimensional inaccuracies [10]. So this study is designed to evaluate the cold cure acrylic resin as an alternative for heat cure acrylic resin and estimate the value of transverse strength when compared to those processed conventionally.

MATERIAL AND METHODS

Metal pattern

Metal stainless steel plate (Iraqi manufacturer) with dimensions of (65mm X 10mm X 2.5mm± 0.03mm) length, width and thickness respectively, according to (ADA specification No.12) were constructed for transverse strength test analysis to save time and effort [11]. The pattern was included in metal flask, for easy removal of the metal dies and to avoid fracture on the molds, space was created on one side of the metal dies in the first pour of dental stone, It allowed for easy retrieval of the metal dies once the 2nd pour had set completely [1], the lower half of each flask was completely filled with type III dental stone (Elite model, Italy) whose surface was flattened with 400μm silicon carbide paper discs (Germany) after the setting reaction.

Mould preparation

The metal pattern was included in metal flask, the lower half of each flask was completely filled with type III dental stone (Elite model, Italy) whose surface was flattened with 400μm silicon carbide paper discs (Germany) after the setting reaction. The patterns were positioned on the stone surface as shown in Figure (1), the additional dental stone then was filled the upper half of the flask which was opened after complete setting under compression (0.5 ton), next the metal mould was removed, and inspecting the cavities for integrity. finally the mould was washed with water and neutral detergent, and coated with a separating medium.

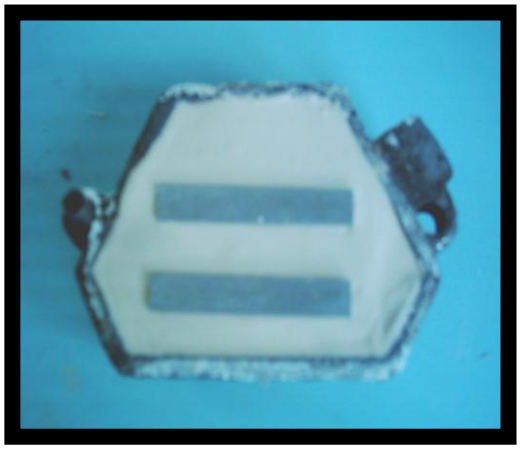

Figure (1)

Mixing and packing of acrylic

Pink heat and cold cured acrylic resin (Major, Italy) was used to fabricate the samples in this study, The mixture of polymethylmethacrylate was prepared in a mixing jar according to the manufacturer's instructions of powder/ liquid ratio by volume. Heat-cured acrylics was mixed (3:1) while cold-cured acrylic mixture was prepared (2.5:1) by volume [12]. Each flask was packed with acrylic resin once it reached the dough stage. Excess material (flash) was removed during trial closure, the flasks were fitted and pressed together in a hydraulic bench press for (5) minutes before polymerization process [13] . Autopolymerized acrylic resin mixture was also prepared and When resin reached the free flowing stage, it was packed into the gypsum moulds created, and pressure was applied using the clamps [1].

Curing and cooling

Curing was carried out by placing the clamped flask of fast curing technique of both heat cure and cold cure acrylic resin in a water bath and processed by heating at 74ºC for about (1.30) hr, then the temperature was increased to 100ºC for (30) minutes (ADA specification No.12) [14], finally 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. While in case of cold cure acrylic resin of low curing technique, flasks containing the acrylic resin dough were left under bench hydraulic press for (2 hrs) at 23Cº ± 5Cº**.** The acrylic patterns were then removed from the moulds [15].

Finishing and polishing

All flashes of acrylic were removed with acrylic bur (Germany), to get a smooth surface , the stone bur (Germany) should be used followed by (120) grain size sand paper (Germany) to remove any remaining small scratches with continuous water cooling. While polishing was accomplished by using bristle brush (china) and pumice (Italy) with lathe polishing machine (Italy). A glossy surface was obtained with wool brush (Germany) and polishing soap (Italy) on dental lathe using law speed of (1500 rpm) which not lead to distortion of the specimens.

Testing procedure

The transverse strength is a combination of tensile and compressive strength and includes some of the elements of the proportional limit and elastic modulous [8]. The transverse strength of acrylic resin specimens was measured in air by three points bending on an instron testing machine, as shown in figure (2).

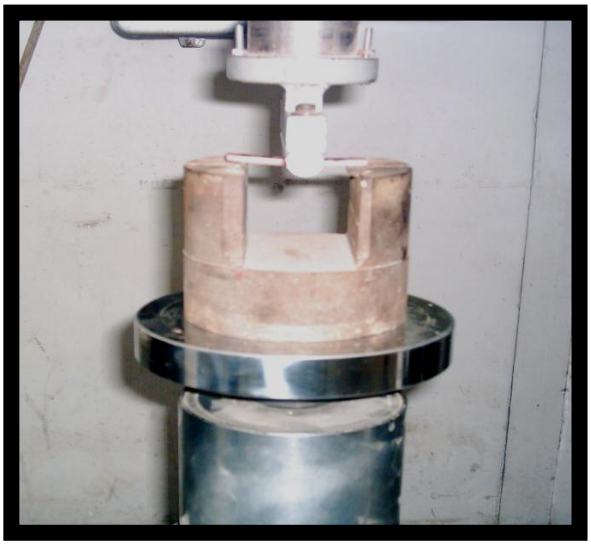

figure (2)

The transverse testing device was supplied with a central loading plunger and two supporting rollers of (3.2mm) in diameter and (10mm) in length. The supports were parallel to each other and perpendicular to the longitudinal centerline. The distance between the center of the support was (50mm). The test specimen was held at the end of two supports, with a constant cross head speed (5mm/ minutes) and the load was measured by a compression load cell of maximum capacity (5KN) [16, 17, 18]. The values of transverse strength were calculated by the following equation [1] :-

$$S = 3PI / 2bd^2$$

S= Transverse strength (N/mm^2)
P= Maximum force on sample
I= Distance between the supports (mm)
b= Width of sample (mm)
d= Depth of sample (mm)

Statistical analysis

The suitable statistical methods were used in order to analyze and assess the results, they include the Descriptive statistics (mean, SD, SEM, minimum & maximum) and Inferential statistics (Analysis of variation ANOVA (f-test) and Least significant difference LSD (f-test)), tests were performed at a confidence level of 95% [19].

Results

Transverse strength test as shown in table (1) and (2) clarifying that there was a statically highly significant increase in transverse strength value ($P<0.01$) when compared between the heat cure acrylic resin (control group) which have mean value of (179.94 ± 20.03) and polymerized by water bath technique in 74ºC for (1 ½) hour then 100ºC for ½ an hour and the cold cure acrylic resin with mean value of (152.27 ± 27.78) which in turn have statically highly significant increase in transverse strength value ($P<0.01$) when compared with that cold cure acrylic resin of (112.34 ± 15.03) mean value that cured chemically (air polymerization) for (2 hours) on bench, show figure (3) .

Table (1): Mean distribution of transverse strength (N/mm^2) test among studied groups.

Studied groups	N	Mean	SD	S. Error	Mini.	Maxi.	ANOVA	
							P-value	Sig.
G1 / Heat resin Water bath (Control group)	10	179.94	20.03	6.335	147	217.6	0.00	Highly Sig.(P<0.01)
G2/ Cold resin Water bath	10	152.27	27.78	8.785	194.27	176.4		
G3/ Cold resin Chemical	10	112.34	15.03	4.756	94.1	141.1		

curing								
Total	30							

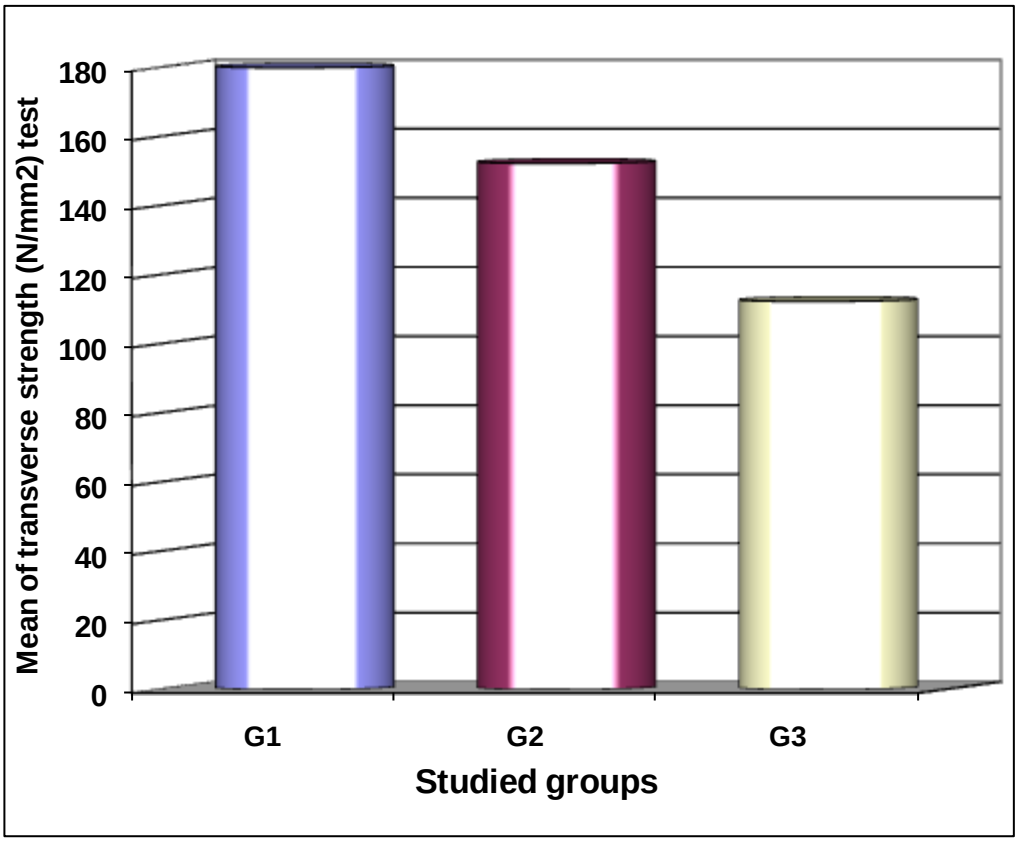

Figure (3): Diagram showing the mean distribution of transverse strength (N/mm^2) test among studied groups.

Table (2): Multi comparison for transverse strength (N/mm^2) test among studied groups.

Studied groups		Comparison of Significant (LSD)	
		P-value	Sig.
G1	G2	0.008	Highly Sig.(P<0.01)
	G3	0.00	Highly Sig.(P<0.01)
G2	G3	0.00	Highly Sig.(P<0.01)

Discussion

Cold cure acrylic resin that processed at 74ºC for (1 ½) hour then 100ºC for (½) an hour appear to be nearly the same effect of transverse strength of heat cure acrylic resin processed in the same manor when compared with it, this may be due to the presence of water during the polymerization, and this water far any type of polymerization does always minimize the evaporation of residual monomers [10, 20, 21]. While in case of cold cure acrylic resin that processed under hydraulic press for (2 hrs) have lower transverse strength value than that of both heat cure and cold cure acrylic resin which processed in water bath, this may be related to inferior transverse strength of self cure acrylic to that of heat cure due to residual monomer and also the method of activation technique [1], and may

be due to the water pressure which observed improvement in transverse strength compared with those prepared under room temperature [9, 22].

Conclusion

This study was concluded that the cold cure acrylic which processed in water bath at 74ºC for (1 ½ hr) then 100ºC for ½ hr have highly increase in transverse strength effect than cold cure acrylic which polymerized under hydraulic press for (2 hrs) in spite of the same curing time, and the heat cure acrylic which processed in water bath have superior effect in transverse strength than cold cure acrylic which polymerized by both water bath and in room temperature.

References

1. Agarwal M.; Nayak A.; and Hallikerimath R. B. (2008): A study to evaluate the transverse strength of repaired acrylic denture resins with conventional heat-cured, autopolymerizing and microwave-cured resins: An in vitro study. Department of Prosthodontia, KLES Institute of Dental Sciences, Belgaum, India. 1(8); 36-41.
2. Ogle R. E; Sorensen S. E.; and Lewis E. A. (1986): A new visible light cured resin system applied to removable prosthodontics. J prosthet Dent. 56(4): 497-507.
3. Powers J. M. and Wataha J. C. (2008): Dental materials properties and manipulation. 1st Ed. Mosby, pag; 29:361.
4 . Graig R. G. (1997): Restorative dental materials. 10th Ed. St. Louis. The C.V. Mosby Com. Chap: 6 and 19; Pag: 126-136, 500- 540.
5. Anusavice K. J. (1996): Phillips science of dental material. 10th Ed. Philadelphia: W. B. Sounders Com. Chap: 10 and 11; Pag: 211-235, 237-271.
6. Graig R. G.; O'Brien W. J.; and Powers J. M. (1996): Dental materials, properties and manipulation. 7th Ed. St. Louis. The C.V. Mosby Com. Pag: 242-264.
7. Leong A.; and Grant A. A. (1971): The transverse strength of repairs in PMMA. Aust J Dent. 16; 232-244.
8. Graig R. G.; and Powers J. M. (2002): Restorative dental materials. 11th Ed. St. Louis. The C.V. Mosby Com.
9. Ray N.(1998): Dental material science. University Dental School and Hospital. Wilton Crok, Ireland. 3: 38-48.
10. Polyzois G. L.; Handley R. W.; and Stafford G. D. (1995): Repair strength of denture base resins using various methods. Eur J Prosthodont Restor Dent. 3:183-6.
11. ADA (1978): American national institute/ American dental association specification NO. 12 for denture polymer. Chicago: council on dental material and devices.
12. Abdul- Karim J. F. (2005): Evaluation of some mechanical properties of acrylic denture base materials relined with different denture reline materials. M. Sc. Thesis, College of Dentistry, University of Baghdad. Pag: 48, 73-76.
13. Rached R. N.; Powers J. M.; and Del-BelCury A. A. (2004): Repair strength of autopolymerizing, microwave and conventional heat- polymerized acrylic resin. J prosthet Dent. 92(1): 79-82.
14. ADA (1999): American national institute/ American dental association specification NO. 12 for denture polymer. Chicago: council on dental material and devices.
15. Walter J. D.; Gloysher. (1972): The properties of self-curing denture bases. Br Dent J; 132:223.
16. Al- Nadawi L. M. (2005): The effect of different surface treatments and joint surface shapes on some mechanical properties of the repaired acrylic denture base resin cured by two different techniques. M. Tech. Thesis, College of health and medical technology, Department of dental technology. pag: 83-85.

17. Al- Ta'ie A. Z. (2006): Evaluation of olive oil as separating medium and it's effect on some physical and mechanical properties of processed acrylic resin denture base (A Comparative Study). M. Tech. Thesis, College of health and medical technology, Department of dental technology. pag: 21-23, 55-65.
18. Al- Fureji N. H. (2006): The effect of different surface treatments and thermal cycling on some of the mechanical properties of the repaired acrylic denture base material. M. Tech. Thesis, College of health and medical technology, Department of dental technology. pag: 50-59.
19. Sorlie D. E. (1995): edical biostatistics & epidemiology: Examination & board review. 1st Ed. Norwalk, Connecticut, Appleton & Lange: 47-88.
20. Phillips R. W. (1996): Skinner's science of dental materials. 10th Ed. Philadelphia, W B Saunders Co.
21. Graig R. G.; O'Brien W. J.; and Powers J. M. (1996): Dental materials, properties and manipulation. 6th Ed. St. Louis. The C.V. Mosby Com. Pag: 222-234.
22. Harrison A.; Magara J. B.; and Hugget R. (1995): The effect of variation in powder particle size on the doughing and manipulations and some mechanical properties of acrylic resin. Eur J Prosthodont rest Dent. (6); 263-268.