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Dimensional stability of acrylic denture base material after poly vinyl pyrrolidone addition

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Key words
acrylic resin, dimensional changes, thermo cycling, polyvinyl pyrrolidone.

Abstract
Problem Denture base dimensional changes were found with commercial theremocured acrylic resins. The dimensional stability of acrylic resin denture base is the main necessity effects the retention and stability of the denture. This study was conducted to measure the dimensional accuracy of experimental prepared material in comparison with control material before and after thermo cycling cured by water bath and microwave. In this stady the total (40) specimens of heat cure acrylic resin lower denture base were cured by water bath and microwave after addition poly vinyl pyrrolidone (PVP). (Experimental). Preparation of modified heat cured denture base acrylic resin was carried out by preparing of (PMMA) (80%) and poly vinyl pyrrolidone (PVP) (20%) and the liquid part composed of methyl methacrylate (MMA) monomer. Evaluation was made by measuring dimensional stability and accuracy. Distances were measured between (3) points marked on denture bases "AB, AC and BC" before and after thermo cycling for both control and experimental groups. The result of this study showed that there was no significant differences ($p>0.05$) between control and experimental groups at three point "AB, AC and BC" before and after thremocycling. Dimensional stability and accuracy was not influenced by addition of PVP to acrylic denture base resin before and after thermo cycling in both heat and microwave treatment.

Introduction

Among the polymer materials introduced in prosthetic dentistry, poly methyl methacrylate (PMMA) is the only proven material for successful denture base on account of its optimal physical properties and excellent esthetics with relatively low toxicity compared to other plastic denture bases [1] . Denture bases are responsible for artificial teeth fixation, stability and distribution of masticatory force over a large tissue bearing area “Support”. The dimensional changes of the denture base result from both polymerization shrinkage and stresses released during flask cooling[2].

Conversely, the variations in curing technique may not significantly alter the pattern of dimensional acrylic resin behavior due to the decrease in the molecular weight of the resulting polymer chain [3].With the object of reducing the variables that alter base stability, several processing techniques have been suggested as alternatives to the conventional heat .water bath. Some studies, however demonstrated that the base adaptation to the stone cast is unsatisfactory, as it is influenced by the base thickness, palate geometry and processing methods [4]. Microwave energy has currently been used as an alternative to conventional methods, although variations in its efficiency have beenreported [5].

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Addition of polyvinyl pyrolidone (pvp) is one of the method used to improve some of mechanical properties of PMMA (6).

This study was designed toevaluate water bath and microwave cured denture base acrylic resin material reinforced with polyvinyl pyrrolidone (PVP) polymer 20%.

Methods

Grouping Samples

A total of (40) samples of heat cured lower acrylic denture base , they were divided in to two groups according to the method of curing (20 for water bath, 20 for microwave) then each group subdivided in to two groups (control and experimental with poly vinyl pyrrolidone (PVP) each group have (10) samples were measured before and after thermocycling.Samples were prepared from pink heat cure acrylic resin (control) and pink heat cure acrylic resin with white powder of polyvinyl pyrrolidone (PVP) polymer (experimental) group with concentration of 20% which has closet testing value in comparison with control group.[7]

Group I

Poly methyl methacrylate (PMMA) + methacrylate (MMA) as control group 2.5:1 by weight. [8]

Group II

PMMA (80% + PVP (20%) + MMA as experimental group (2.5:1) by weight.

Specimens Preparation

Cast Preparation:

The mandibular edentulous stone casts were made from type ш distone materials Fig(1).

Heat cure Record Base Preparation

Flask preparation:

All the parts of the flask were lubricated with a fine film of Vaselineto facilitate mold removal from the metal parts. The stone cast with the record base was flasked in the lower half of a traditional brass flask with (1:1) plaster / stone mixture for its least amount of setting temperature in comparison with other plaster / stone proportions [9]where the edges of the cast were leaved with upper edge of the lower half of the flask. The first layer allowed to dry after which separating medium was painted for all the exposed stone surfaces and denture bases to keep the investing material from adhering when the second half of the flask is filled with gypsum investment materials. This separating medium comes in the form of a liquid, leaves a very fine film after drying. Then, the upper half of the flask was assembled to the lower half and filled with the same plaster / stone mixture ratio. The second investment layer was poured up to the upper edge of the flask. After one hour, the flask was placed in boiling water for 5 min for wax elimination. The flask parts were separated and the record base was removed. Even thickness of separating medium was applied as a mold separator on the surface of the stone and the cast Fig (2).

Proportioning, Mixing and Packing the Acrylic Resin

Pink heat cured acrylic resin was mixed with a polymer monomer mixing ratio of 3:1 by volume or 2.5:1 by weight according to the manufacturer instructions for the control samples,(80% PMMA + 20% PVP) were mixed with the same polymer monomer mixing ratio for the experimental samples. For each flask, a measured volume of monomer liquid (MMA) was placed in a clean, dry porcelain jar followed by slow addition of powder, then stirred with a clean wax knife until the monomer and polymer were thoroughly mixed, then the jar was covered until the mixture reached a consistency (dough stage) suitable for packing into gypsum mold. The resin was removed from the jar, rolled and packed into the mold which previously had been treated with separating medium.

A poly ethylene sheet was used over the acrylic resin as a separating medium between the upper and the lower halves during the initial flask closure in a hydraulic press under a load of 850 keg[10]. The flask was removed from the press, opened carefully, the poly ethylene sheet was removed and the acrylic resin excess (flash: which is the excess material extruded beyond the border of the cast onto the investing material) was trimmed with a wax knife. At this stage (before the final

closure) amalgam was placed as a reference points for dimensional changes measurements Fig(3).

The amalgam was placed in three points which were previously marked on the stone cast with the aid of the surveyor, the cast aligned to be parallel with the base in zero tilt position on the table of the surveyor. The anterior point was placed with a reference of labial frenum from which a mid-line was drawn passed along the mandibular stone cast (it was placed 10mm from the upper anterior border of the stone cast) . Each one of the posterior points was placed at a distance of 39mm from the anterior reference point (right & left) at the crest of the residual ridge and at a distance of 16mm from the upper border of the stone cast and 7mm posteriorly to the buccal frenum from each side. Amalgamator was used for mixing amalgam capsules according to the manufacturer instructions and the amalgam was placed by using amalgam carrier in order to ensure standardization in the amount of the amalgam added and also to obtain a uniform round reference point with uniform depth each time for all points at all record bases.

During the application of final closure, metal-to-metal contact of the flask halves was completed in the press, the flasks were placed in traditional clamps after final pressing in a hydraulic press under a load of 1250 keg for 5 min .[10]

Curing & Cooling:

Curing was carried out by placing the clamped flask in a thermostatically controlled water bath and processed by heating at 74^0C for 1.5 hour and the temperature was then increased to the boiling point for half an hour according to ADA, No.12 (1999). After completing the curing, the flask was allowed to cool slowly at room temperature for 30 minutes, followed by a complete cooling of the flask with tap water for 15 minutes before deflasking .The acrylic patterns were then removed from the stone mound.

Finishing & Polishing

All flashes of acrylic were removed with an acrylic bur. To get a smooth surface, the stone bur should be used followed by (120) grain size sand paper to remove any remaining small scratches with continuous water cooling. While polishing was accomplished by using bristle brush and pumice with lathe polishing machine, a glossy surface was obtained with wool brush and polishing soap on dental lathe using low speed (1500 rpm) and the specimens were continuously cooled with water to avoid overheating , which may lead to distortion of the specimens Fig (4).

Conditioning

The specimens were conditioned for two weeks in distilled water at 37^0C.

Microwave Record base Preparation

The manufacturer'sinstructions was followed in proportion and mixing of the polymer and monomer , the polymer/ monomer ratio used was 2.25 mg/ 1ml. the mixture was packed after the dough stage was reached by wax knife, with slight excess of material to account for polymerization shrinkage and finishing [11].

Curing

The microwave used in this study with 500 watts, maximum output representing 10% power level of control setting. The power level was set at 50% to get 450 watt output for 3 minutes Fig (5). Following completion of curing the flasks were allowed to cool slowly at room temperature for 30 minutes then immersed in water for 15 minutes after that the acrylic specimens were removed from the stone mold then finished and polished.

Conditioning of the specimens

According to the ADA specification No. 12 (1999) all the samples were stored in distilled water at 37^0C for 48 hours before testing.

Dimensional Changes Measurements

Dimensional changes measurements were done for all of the samples in each tested group, 40 mandibular stone casts with their corresponding denture bases (controland experimental) before and after thermo cycling.

Denture bases and stone casts were kept in an incubator under controlled conditions such as temperature at 20 ±1 C° and relative humidity at 50% ± 5% [12] the measurements were made using a digital vernier which is capable of measuring 0.01mm Fig (6).

The sample was placed on the horizontal table of the surveyor and the digital vernier was used to measure the distance between A-B, A-C and B-C for each sample (within each amalgam round reference point a colored pin point was marked for the standardization of the measurement with a distance of 10.5 mm from the outer upper anterior border of the stone cast to the center of anterior amalgam reference point at the crest of the ridge, and a distance of 16.5 mm from the outer upper border of the stone cast to the center of posterior amalgam reference points at the crest of the ridge (right and left), and a distance of 21.5mm from the outer upper posterior border of the stone cast)

After the completion of the measurements all the samples in each tested group (control and experimental) were thermo cycled between (5C° to 55C°± 2C°) in a 60 sec cycles for 3 days (approximately 500 cycle) with an immersion time of 30 sec / bath and a total cycle of time of 1 min . The thermo cycling machine consists of two parts; the upper manual part which holds the samples to be immersed in hot and cold bathes consist of two sided rods, at the end of each rod there is a plastic disc and a central holder or axis which was fixed inside a specific base located between the two bathes .The immersion procedure of samples from one bath to another were done manually.

Samples change from hot to cold bath and from cold bath to hot bath the cycle took 60 sec (1 min). The procedure was repeated in the same manner until a total thermo cycling procedure were 500 cycle completed in three days; in the first day 175 cycle for 6 hours; in the second day 175 cycle for 6 hours and in the third day 150 cycle for 5 hours[7]. In the first two days the samples were stored in a closed plastic bag for the rest of the day after the end of thermocycling, while for the third day the samples were tested immediately after the end of the procedure using the digital vernier.

Results

The dimensional stability and accuracy of control and experimental denture bases was measured at three distances (AB, BC, and BC) which corresponded to distances between three points which were (A, anterior point, Band C, posterior points right & left) before and after thermo cycling

Dimensional stability and accuracy of the heat cure acrylic denture bases (control) at "AB,AC and BC distance " with the experimental denture base before and after thermocycling.

Table (1) shows the descriptive statistics with one way ANOVA test. The result have shown that the hight mean value were obtained from point BC (42.88) while the lowest mean value were obtained from "AC" point (32.89) from ANOVA test we can see that there is no significant differences (P>0.05) among the tested group.

Discussion

Dimensional changes may modify the planned vertical occlusion dimension, and cause traumas in mucosa and bone loss. Careful measures have been taken to overcome some in accuracies such as base distortion and displacement of artificial teeth factors that lead to less of stability and retention and necessity of more difficult occlusal adjustments.

The adaptation of denture base depend on many factors which include the method and the material used for its construction. It is self-evident that the more dimensionally accurate and stable a material is the more retentive and adaptive will be the denture. Therefore the properties of the denture base material used are considerable importance in denture fabrication. Additionally high thermal stability and anti-abrasion ability are also expectable in an anti-shrinkable resin because of its network structure [13, 14].

In the present study, there was no significant differences (p > 0.05) in the

distance at "AB","AC" and "BC" group of heat polymerized as shown in tables (1,2,3,4) this may be considered the denture bases were made with 2mm thickness and according to previous studies [15] this fact may reduce dimensional changes in the base also long polymerization cycle in water bath was reported as a preferable because less dimensional changes occurs in the denture base [16,17] on the other hand, the fast cycle is characterized by the occurrence of incomplete resin polymerization with temperature beaks and a great deal of exothermic heat [18].This result is disagree with previous study[7] who concluded that there was significantly differences between control and experimental groups after PVP addition.

In microwave cured method there was no significant differences ($p > 0.05$) in the distance at "AB","AC" and "BC" groups as shown in tables (5,6,7,8) . This due to acrylic denture base submitted to 3 minute cycles of microwave at 500w. Treatment in microwave oven at 604w for 10 minute produced clinically un acceptable alteration in adaptation of acrylic resin denture bases to the stone caste, which contraindicate this time / power setting. on the other hand, micro waving of the dentures for 3 minute at 500w did not alter their fitting and stability this results is agreement with work the previous studies [19, 20] who reported that dimensional changes not clinically significant in specimens submitted to 3 minute cycles of microwave at 500w.In this study thermo cycling was used in control and experimental groups to simulate intra oral condition more closely. The results showed that there was no statistically significant difference between thermo cycled and non-thermo cycled specimens as shown in all tables this could be attributed to the number of thermo cycles used. The lower number of cycles employed in the present study (500 cycles) and result is in agreement with the previous study [1].

Fig (1) stone cast

Fig (2) the stone cast with flasked in the lower half of the flask.

Fig (3) Amalgam capsules and amalgam carrier.

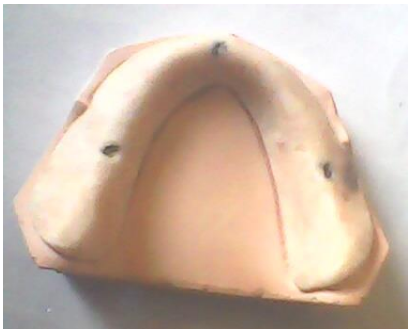


Fig (4) Denture base with point of amalgam

Fig(5) Microwave oven used in the study.

Fig (6) Digital Vernier.

Table (1): Descriptive statistics of the mean of control at AB, AC and BC before thermo cycling.

	No.	Mean	Max	Min	SD	ANOVA F-test	Groups	Sig
AB	10	35.40	35.48	35.31	0.045	0.4	0.68	N.S
AC		32.89	32.94	32.85	0.030			
BC		42.88	42.91	42.85	0.019			

Table (2): Descriptive statistics of the mean of control at AB, AC &BC after thermocycling.

Groups	No.	Mean.	Mar	Min	SD	ANOVA F-test	P-value	Sig
AB	10	35.51	35.8	35.4	0.146	0.046	0.957	N.S
AC		32.9	32.97	32.85	0.033			
BC		42.86	42.92	42.85	0.040			

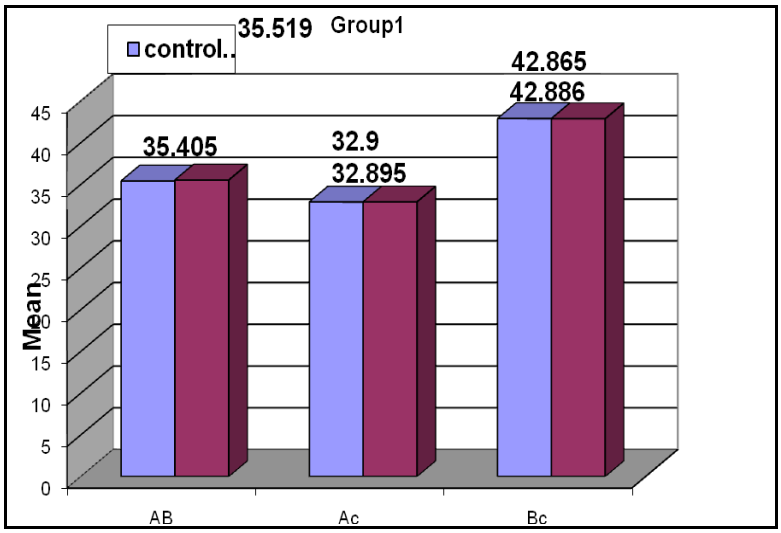


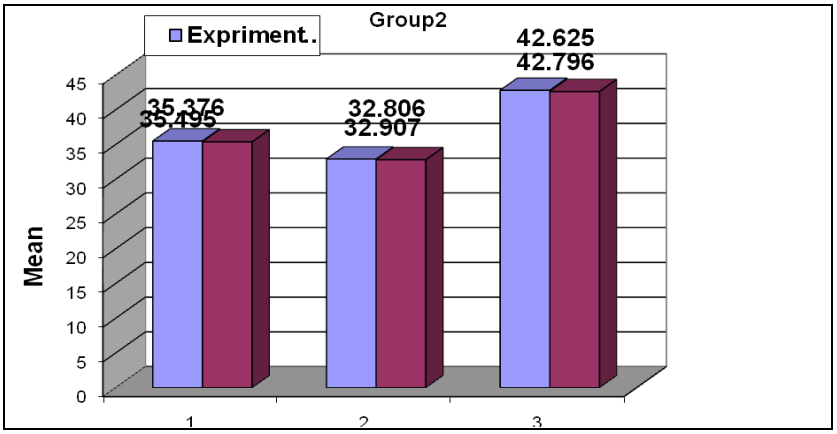
Fig (7) Mean values of dimensional stability among tested groups (control) in (mm)

Table (3): Descriptive statistics of the mean of experimental group before thermocycling

Groups	No.	Mean.	Max	Mir	SD	ANOVA F-test	P-value	Sig
AB	10	35.49	35.55	35.41	0.039	0.59	0.54	N.S
AC		32.90	32.98	32.85	0.040			
BC		42.79	42.88	42.73	0.055			

Table (4-4): Descriptive statistics of the mean of experimental group before thermocycling .

Groups	No.	Mean.	Max	Min	SD	ANOVA F-test	P-value	Sig
AB	10	35.37	35. 5	35.22	0.09	0.052	. 0.948	N.S
AC		32.80	32.87	32.73	0.044			
BC		42.62	42.71	42.45	0.014			



Fig(8) mean values of dimensional stability among tested groups (Exprimental) in (mm)
Dimensional stability & accuracy of Microwave acrylic denture base (control) AB, AC, BC with the experimental denture bases before and after theromcycling .

Table (5): Descriptive statistics of the mean of control group before theromcycling.

Groups	No.	Mean.	Max	Mir	SD	ANOVA F-test	P-value	Sig
AB	10	35.85	35. 92	35.72	0.06	0.541	. 0.602	N.S
AC		32.77	32.87	32.7	0.04			
BC		43.78	43.42	43.65	0.08			

Table (6) Descriptive statistics of the mean of control group after theromcycling.

Groups	No.	Mean.	Max	Mir	SD	ANOVA F-test	P-value	Sig
AB	10	35.75	35. 89	35.56	0.121	3.066	. 0.155	N.S
AC		32.88	32.93	32.81	0.038			
BC		43.79	43.87	43.72	0.045			

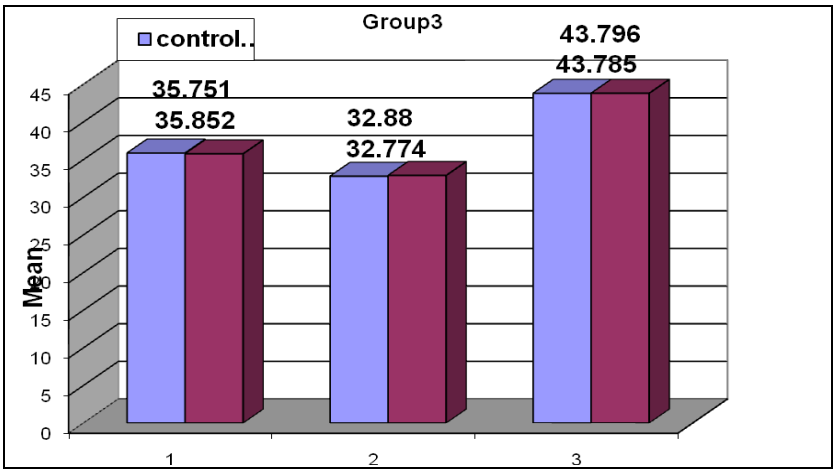


Fig (9) Mean values of dimensional stability among tested group (control) in (mm)

Table (7) Descriptive statistics of the mean of experimental before thermocycling.

Groups	No.	Mean.	Max	Min	SD	ANOVA F-test	P-value	Sig
AB	10	35.87	35. 95	35.8	0.05	1.26	. 0.30	N.S
AC		32.82	32.87	32.74	0.04			
BC		43.81	43.88	43.75	0.04			

Table (8) Descriptive statistics of the mean of experimental after thermocycling.

Groups	No.	Mean.	Max	Min	SD	ANOVA F-test	P-value	Sig
AB	10	35.839	35. 94	35.73	0.06	0.61	. 0.55	N.S
AC		32.805	32.85	32.76	0.02			
BC		43.817	43.9	43.72	0.05			

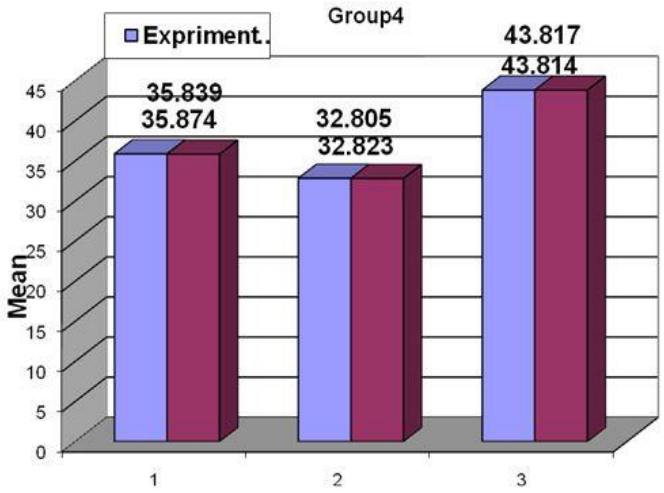


Fig (10) Mean values of dimensional stability among tested group (Experimental) in (mm)

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