

## **Evaluation of the Effect of Addition of Poly Vinyl Pyrrolidone on, Dimensional Changes of Heat Cured Acrylic Resin Denture Base Material**

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**Abstract:** *The most common materials used for fabrication of denture bases are poly methyl methacrylate (PMMA). 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. A(10) specimens for each experimental group were tested . All specimens were cured by using short curing cycle (90 min.at 74C° followed by 30 min .at 100C°).Evaluation was made by measuring dimensional stability and accuracy of the prepared denture base material in comparison with the control denture base material . The dimensional accuracy of*

*acrylic resin denture base is the main necessity ,where it effects the retention and stability of the denture .A silicon mold was used to prepare a(40) stone mandibular master casts (control and experimental). Acrylic dough was prepared and packed for processing ,the flask were closed with pressure technique and placed in clamps after final closure .Distances were measured between (3) points marked on denture bases before and after thermocycling for both control and experimental groups. For AB and BC distances the PVP had improved the dimensional stability and accuracy before and after thermocycling while for AC distance the control group material before and after thermocycling improved the dimensional stability and accuracy.*

## **1. Introduction**

PMMA is the most commonly used material in denture base construction since 1930[17, 11]. Denture bases are responsible for artificial teeth fixation, stability and distribution of masticatory forces over a large tissue bearing area "support" [4]. An essential and critical factor in the retention and stability of complete denture is the dimensional changes that occur in the denture base during polymerization reaction (it is an additional reaction that required the activation of the monomer to polymer [9, 12, 19]. In addition to

polymerization shrinkage many factors may influence the base dimensional changes such as the resin flasking method, time and temperature correlation during the curing procedure [15], thermal contraction by flasking cooling and strain caused by stress release during deflasking causes diminished adaptation of the denture to the tissue. This shrinkage may be partially improved by water sorption, the resilience of the gingival mucosa and the saliva film that forms between the acrylic resin base and the soft tissue [5,7,13]. This study was designed to evaluate heat cured denture base acrylic resin (PMMA) material reinforced with Poly Vinyl Pyrrolidone (PVP) polymer {20%}. It is intended to evaluate some properties of heat cured acrylic resin denture base material before and after the addition of (PVP).

## 2. Aims of the Study

To evaluate the dimensional changes of the experimental prepared material in comparison with the control material before and after thermocycling .

## 3. Materials and Methods:

The total number of samples were "40" samples. Samples were prepared from pink non veined heat cure acrylic resin (control group), and pink non veined heat cure acrylic resin with white powder of poly vinyl pyrrolidone (pvp) polymer (experimental group) with concentration of [20%] which has closest testing value in comparison with the control group [2].

**Group I:** poly methyl methacrylate (PMMA) + methyl methacrylate (MMA ) as control group ( 2.5 : 1) by weight [1] .

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

#### **4. Dimensional Changes**

The total number of samples "mandbular edntulous stone casts with their corresponding denture bases" were '40' samples. They were divided into two main groups according to the type of denture base material (control and experimental). Each main group was subdivided into two subgroups (before and after thermocycling, were each subgroup consisted of 10 samples. the thickness of the denture base was '2mm' [16].

#### **5. Cast Preparation**

The mandibular edentulous stone casts were prepared from an edentulous silicon mold. The silicon mold was poured with type IV extra hard stone mixed according to manufacturer instructions at a mixing ratio of 22-23 ml of water to 100 gm of powder.

#### **6. Record Base Preparation**

The record base was prepared by using a biostar machine . The cast was placed on the biostar table and dipped in the biostar beads just below the borders, the biostar plate (Biocryl " C " : is a pure acrylic material with no monomer residues . It is used for the record bases formation and retainers, round in shape of size 2.0 mm thickness, 125mm diameter, clear color, heat 75 sec, code 217, cool 300sec), the cast with the plate was removed from the machine, cutting, trimming and finishing for the plate using biostar burs and sealed with wax on the cast. This procedure was repeated for all the cast samples.

#### **7. Flask preparation**

Flasking is the process of investing the cast with the waxed denture in a flask to make a sectional mold used to form an acrylic resin denture base. All the parts of the flask were lubricated with a fine film of Vaseline to facilitate mold removal from the metal parts. The stone cast with the record base was flaked in the lower

half of a traditional bass flask with (1 : 1) plaster/stone mixture. [3, 10, 16]

A 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.

### **8. Packing the Acrylic Resin**

Pink non veined 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. packing the flask in a hydraulic press under a load of 850 kgf [6]. At this stage (before the final closure) amalgam was placed as a reference points for dimensional changes measurements. 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 first point (A) was placed interiorly, while the other two points (B&C) were placed posteriorly (right & left). The anterior point was placed with a reference of labial frenum. 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 16 mm from the lower border of the stone cast and 7 mm posteriorly to the buccal frenum from each side the flasks were placed in traditional clamps after final pressing in a hydraulic press under a load of 1250 kgf for 5 min [6]. Curing was carried out by placing clamped flasks in a curing unit, the flasks

were immersed in water, heat source was operated for 90 min at 74 C° then boiled for 30 min, Fig(2).

## 9. Deflasking:

After completing the curing cycle, the flasks were allowed to cooling down slowly in the water bath for 30 min then removed from the water bath and allowed to be cool at the bench for 3 hours before the base were deflasked.

## 10. Dimensional Changes Measurements :

Denture bases and stone casts were kept in an incubator under controlled conditions such as temperature at  $20 \pm 1$  C° and relative humidity at  $50 \% \pm 5 \%$  [18] until the measurements were made using a digital vernier which is capable of measuring 0.01mm. the digital vernier was used to measure the distance between A-B, A-C and B-C for each sample ( within each amalgam square reference point a colored pin point was marked for the standardization of the measurement with a distance of 10.5mm from the outer anterior border of the stone cast to the center of anterior amalgam reference point at the crest of the ridge, and a distance of 16.5mm from the outer 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 posterior border of the stone cast) Fig 1. After the completion of the measurements all the samples in each tested group (10 control and 10 experimental ) were thermocycled between ( $5C^{\circ}$  to  $55C^{\circ} \pm 2C^{\circ}$ ) then the samples were tested immediately using the digital venires .

## 11. Results and Discussion

Dimensional stability and accuracy of the control acyclic denture bases with experimental denture bases before and after thermocycling where the control group before thermocycling show

the highest mean. While the experimental group after thermocycling show the lowest mean. Table (1) shows the descriptive statistics with one way ANOVA test which includes mean, standard deviation, standard error, minimum, maximum and range values of the mean in control and experimental groups before and after thermocycling. The results have shown that the control group before thermocycling has the highest mean value (41.7838) while the lowest mean value is shown in experimental group after thermocycling (41.4256). From ANOVA test we can see that there is a significant difference ( $P \leq 0.05$ ) among the tested groups. Table (2) represents the least significant difference [ LSD ] of multiple comparison test between tested groups; which demonstrates a significant difference ( $P \leq 0.05$ ) between control group before thermocycling and control group after thermocycling and experimental group before and after thermocycling the statistical results showed that: there was a statistical difference between the control group before thermocycling and the control group after thermocycling, these differences could be due to the effect of thermocycling technique in thermocycling procedure, the osmotic pressure is proportional to the difference in ionic concentration between the polymer and the external liquid. Depending on the properties of material these droplets might be restrained

and reduced in size this explanation is in agreement with (Yanikoglu & Duymus, 2004). The control group before and experimental group after thermocycling. and control group after thermocycling and experimental after thermocycling these differences could be due to the presence of P.V.P in the experimental material which makes it more rigid increase stiffness, reduced porosity which lead to reduce water sorption and solubility and reduced the resiliency of the experimental material because it is a more cross linked with P.M.M.A creating great bonding between P.V.P and P.M.M.A. This is in agreement with (Jorge et al., 2003; Shakeel et al., 2007; Mohammed, 2008).

## 12. Conclusions

Dimensional stability and accuracy was influenced by type of denture base material which might affect the properties of denture during the processing procedure. the mean of experimental material before and after thermocycling was significantly lower than that of control before thermocycling.

**Table (1) Descriptive statistics of the mean in all the tested groups and the P-value among them.**

Groups	No.	Mean 'mm'	Max.	Min.	Range	Standard Deviation	Standard Error	ANOVA F-test	Sig.
Control Before	10	41.7838	42.87	41.09	1.78	0.61848	0.19556	4.645	0.031
Control After		41.5033	42.16	40.14	1.51	0.47115	0.14899		
Experimental Before	10	41.5523	41.98	40.96	0.98	0.34911	0.11039		
Experimental After		41.4256	42.23	40.87	1.56	0.51103	0.16152		
Total	20								

S. = ( $P \leq 0.05$ ).

**Table (2) the LSD of multiple comparison test between all the tested groups.**

<b>Studied Groups</b>		<b>P-value</b>	<b>Sig.</b>
<b>Control-Before</b>	Control-After	0.018	S.
	Experimental-Before	0.198	N.S.
	Experimental-After	0.034	S.
<b>Control-After</b>	Control-Before	0.018	S.
	Experimental-Before	0.348	N.S.
	Experimental-After	0.018	S.
<b>Experimental-Before</b>	Control-Before	0.018	S.
	Control-After	0.604	N.S.
	Experimental-After	0.268	N.S.
<b>Experimental-After</b>	Control-Before	0.198	N.S.
	Control-After	0.348	N.S.
	Experimental-Before	0.268	N.S.

**S.=( $p \leq 0.05$ ).**

**N.S.=( $P \leq 0.05$ )**



**Figure 1, Samples.**



**Figure 2, Samples after flasking**

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## تقييم تاثير اضافة البوليمر فنيل بايروليدون على دقة ابعاد قاعدة الطقم الراتنجي الاكريلي

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### المستخلص

تعتبر مادة بوليمر مثيل ميثاالكريليت اكثر المواد شيوعا في عمل اطقم الاسنان المبلمرة حراريا. في هذه الدراسة تم خلط بوليمر مثيل ميثاالكريليت (80%) وبوليمر فنيل بايروليدون (20%) وتم خلطها مع سائل مثيل ميثاالكريليت. تم تحضير (40) عينة بمعدل (10) عينات لكل اختبار من كل مادة. لكل العينات تم غمر القوارير في حوض ماء بدرجة حرارة الغرفة وتم التعهد بدورة معالجة قصيرة (سخنت حتى درجة 74 مئوية لمدة 90 دقيقة ثم تركت لتغلي لمدة 30 دقيقة). التقييم تم بدراسة بعض الخواص الفيزيائية لعينات المادة التجريبية مثل دقة ابعاد قاعدة طقم الراتنج الاكريلي ومقارنتها مع عينات المادة القياسية .

دقة ابعاد قاعدة طقم الراتنج الاكريلي تشكل ضرورة اساسية ، حيث ان لها تاثير مباشر في عملية ثبات واستقرار الطقم. استعمل قالب سيليكوني لتحضير (20) قالب علوي رئيسي من الحجر الصلب . قسمت هذه القوالب الى مجموعتين حسب نوع المادة المستخدمة لتحضير قاعدة الطقم (قياسية وتجريبية) حيث ان كل مجموعة تحتوي على (10) عينات ، تم قياس المسافات بين ثلاث نقاط محددة على قاعدة الطقم (A في الامام وB&C في الخلف) باستعمال الورنية الرقمية قبل وبعد التدوير الحراري لكلا المادتين

اظهرت النتائج ان البوليمر فنيل بايروليدون يعطي احسن نتائج لابعاد قاعدة الطقم قبل وبعد التدوير الحراري وان المادة القياسية تعطي احسن النتائج بعد التدوير الحراري.