

# Residual Monomer and Transverse Strength Evaluation of Auto Polymerized Acrylic Resin with Different Polymerization Treatment.

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## ABSTRACT

**Aims:** The aims of this study are to determine the effect of different polymerization treatment on the transverse strength and residual monomer of auto polymerized acrylic denture base. **Materials and Methods:** Sixteen samples of heat cured acrylic resin were prepared as a control samples. Eighty samples of auto polymerized acrylic resin were prepared with different polymerization treatments to be tested for transverse strength and residual monomer concentration. These polymerization treatments were carried out by: (1) Open air polymerization treatment, (2) Under hydraulic pressure, (3) Under clamp pressure, (4) Water bath post polymerization. (5) Microwave post polymerization. One half of specimens were subjected to transverse strength test and another one subjected to residual monomer test. Data were analyzed using analysis of variance and Duncan's Multiple Range Test. **Results:** The result of this study showed that the microwave post polymerization treatment had significantly higher transverse strength, and also showed that the residual monomer significantly lower with microwave and water bath post polymerization treatment. **Conclusions:** The fracture resistance was improved after post polymerization treatment for auto polymerized acrylic denture base with microwave, and the adverse effect of monomer was decreased by water bath and microwave post polymerization treatment. **Key Words:** Auto polymerized acrylic resin, residual monomer, transverse strength, polymerization treatment

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## INTRODUCTION

The auto polymerized acrylic resin has multiple uses in dentistry such as denture base, record base, orthodontics appliances, denture repair and other. The auto polymerized acrylic denture base materials have a wide range of toxic effect, and lower mechanical strength (less than 80%) when compared with heat polymerized acrylic denture base resin<sup>(1,2)</sup>. This occurs, because there is a less residual monomer in heat-polymerized acrylic resins than in auto polymerizing acrylic resins<sup>(3)</sup>. The reason for the higher residual monomer content in the auto polymerizing acrylic resins is due to the low degree of conver-

sion achieved by the use of a chemical activator, as opposed to that generated by heat activation<sup>(4)</sup>. Residual monomer has been shown to adversely affect mechanical properties of acrylic resins. In addition, residual monomer can elicit irritation, inflammation, and an allergic response in oral mucosa<sup>(1,5)</sup>. Placing of auto polymerized acrylic resin in hot water during polymerization (60–80°C) Water condition may produce less residual monomer in an auto polymerizing acrylic resin, and transverse strength of the resin two time greater when compared with polymerization at 23°C (open to air). This lead to obtain greater increased mechanical properties

and long lasting performance of auto polymerized acrylic resin<sup>(6,7)</sup>. A study showed microwave irradiation of an auto-polymerizing acrylic resin soon after polymerization decreased the residual monomer content by nearly 25%, with an increase in the glass transition temperature.<sup>(8)</sup> Microwave post polymerization resulted in a higher degree of conversion and higher flexural strength of an auto polymerizing acrylic resin repair material<sup>(9,10)</sup>.

While, another study showed that the transverse strengths of auto polymerized acrylic resin were obtained with 20°C and 37°C curing temperatures higher than that were obtained with the 65°C and 90°C curing temperatures<sup>(7)</sup>.

The aims of this research are to evaluate the effect of different polymerization treatments on the transverse strength of the auto polymerization acrylic resin. In addition to find which one of the these polymerization treatments have the less adverse effect (residual monomer).

## MATERIALS AND METHODS

In this study a hard elastic foil was prepared and designed with  $65 \pm 0.3 \times 10 \pm 0.03 \times 2.5 \pm 0.03$  mm (length, width, thickness respectively) dimension to prepare a mold for transverse strength (TS) samples test (ADA Specification NO 12)<sup>(11)</sup>, and with  $20 \times 20 \times 3$  mm (length, width, thickness respectively) dimension to prepare a mold for residual monomer (RM) samples test<sup>(12)</sup>. These prepared hard elastic foils (for transverse strength and residual monomer tests) were invested in dental stone that mixed in 32gm/100 ml (powder/ water) ratio<sup>(13)</sup>, and placed in the lower half of the flask then glass slab was placed against the first half ( which is considered a polish surface) till the stone set.

After final setting of stone material, a conventional flasking procedure was used for the preparation of eighty auto polymerized acrylic resin samples (Major Prodotti Dentari S.P.A Italy) and sixteen heat cured acrylic resin (Major Prodotti Dentari S.P.A Italy) samples by mixing an auto polymerized acrylic resin polymer and monomer in glass jar (3:1 ratio according to the manufacturer instruction) and the dough

packed by using a hydraulic press in stone mold and the following procedures were done:

1. Deflasking was carried out and the dough left to be set in the room temperature ( $23 \pm 2^\circ\text{C}$ ) for 15 minutes to set (open to air)<sup>(14)</sup>.
2. Keep the flask under the hydraulic press for 15 minutes to set (under hydraulic press).
3. The flask was removed from the press and repressed by using the flask clamp for 15 minutes to set (under clamp pressure).
4. The flask was removed from the press and repressed by using the flask clamp then placed in hot water ( $80^\circ\text{C}$ ) for 15 minutes to set (water bath post polymerization).
5. The flasking procedure was carried out by using a new Iraqi fiber reinforced plastic flask (special designed flask for microwave)<sup>(15)</sup>, and the acrylic resin dough was packed by using a hydraulic press then the flask placed in microwave for 15 minutes at 80 watts for each side of the flask and for 1.5 minutes at 500 watts (microwave post polymerization)<sup>(15)</sup>.

The resulted forty samples of auto polymerized acrylic resin that prepared for TS test was collected and stored in distilled water for 48 hours at  $37 \pm 1^\circ\text{C}$ .

After incubation period, the samples was tested by three point transverse testing machine (Inc. Model CN, 472 EVANSTON 111- USA). Transverse strength was calculated according to the following equation.<sup>(16)</sup>

$$TS = 3WL/2bd^2.$$

{TS = transverse strength (MPa). W = maximum load at midpoint of the sample (Kg). L = distance between the supports (50 mm). b = width of the sample (10mm). d = thickness of the sample (2.5mm)}.

The resulted forty samples of auto polymerized acrylic resin that prepared for RM test was immersed in distilled water in sealed glass container for seven days at  $37^\circ\text{C}$  then the collected supernatant medium was monitored using ultraviolet visible spectrophotometer (CECIL 2000) ( $\lambda = 254\text{nm}$ ) compared with pure monomer.

A linear calibration curve of Methyl Methacrylate (MMA) concentration as a function of absorbency at 254 nm was obtained using MMA standard aqueous solutions ranged 0.005–0.125 mg/ml<sup>(17)</sup>.

The results were expressed as a percentage of released residual monomer mass with respect to the weight of specimens (% W/W)<sup>(18, 19)</sup>.

In this study collected data of TS and RM samples were analyzed by analysis of variance (ANOVA) and Duncan's Multiple

Range Test.

## RESULTS

Table (1) demonstrated that there were significant differences between different polymerization treatment ( $P < 0.0001$ ). Duncan's Multiple Range Test indicated that microwave post polymerization treatment ( $79.313 \pm 1.4126$  Mpa) was significantly more resistance to fracture load than other group (Figure 1).

Table (1): Analysis of variance (ANOVA) of transverse strength for different polymerization treatment of auto polymerized acrylic resin.

| Source of variance       | DF | Sum of square | Mean square | F- value | P-value |
|--------------------------|----|---------------|-------------|----------|---------|
| Polymerization treatment | 5  | 5074.3        | 1014.9      | 44.64    | 0.000   |
| Error                    | 42 | 954.8         | 22.7        |          |         |
| Corrected total          | 47 | 6029.1        |             |          |         |

DF: degree of freedom

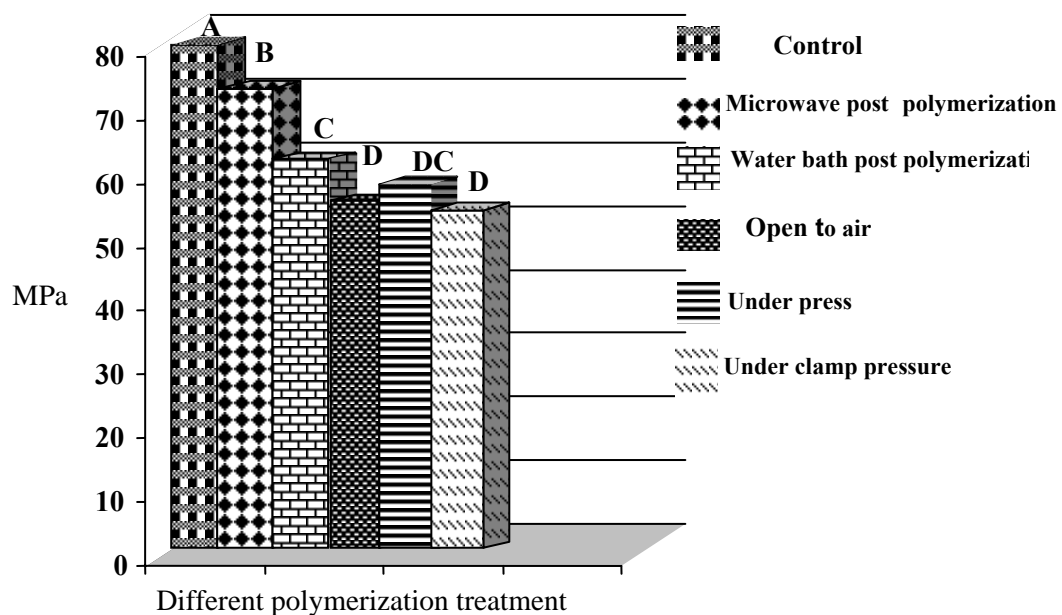


Figure (1): Table (2) Duncan's Multiple Range Test of transverse strength for different polymerization treatment of auto polymerized acrylic resin.

Analysis of variance showed that there were significant differences between RM concentration of different polymerization treatment ( $p < 0.0001$ ) Table(2). Duncan's Multiple Range Test indicated that

microwave and water bath post polymerization treatment ( $1.80 \times 10^{-3} \pm 1.58 \times 10^{-4}$  and  $1.82 \times 10^{-3} \pm 2.95 \times 10^{-4}$ ) were significantly lower residual monomer concentration than other groups (Figure 2).

Table (2) Analysis of variance (ANOVA) of residual monomer for different polymerization treatment of auto polymerized acrylic resin.

| Source of variances      | DF | Sum of square          | Mean square            | F-Value | P- value |
|--------------------------|----|------------------------|------------------------|---------|----------|
| Polymerization treatment | 5  | $0.178 \times 10^{-7}$ | $0.036 \times 10^{-7}$ | 41.7    | 0.00     |
| Error                    | 42 | $0.036 \times 10^{-7}$ | $0.001 \times 10^{-7}$ |         |          |
| Corrected total          | 47 | $0.214 \times 10^{-7}$ |                        |         |          |

$10^{-7}=1/10000000$ ; Df: Degree of freedom

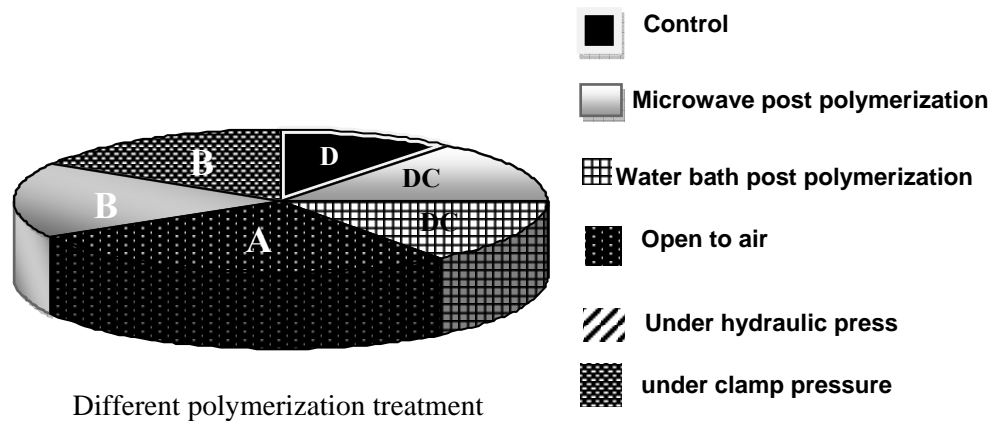


Figure (2): Duncan's Multiple Range Test of residual monomer for different polymerization treatment of auto polymerized acrylic resin

### DISCUSSION

The result of this study showed higher significant TS of auto polymerized acrylic resin with microwave post polymerization than other tested groups.

Those finding were in agreement with other studies<sup>(9,10)</sup>. The scientific cause for such result is related to that microwave irradiation of an auto polymerizing acrylic resin increased the degree of conversion, and the glass transition temperature (Tg) of an auto polymerizing resin. So, microwave post polymerization resulted in a higher degree of conversion, low plasticizer and higher flexural strength of an auto polymerizing acrylic resin repair material<sup>(8)</sup>.

The result of the study showed that RM of microwave and water bath post polymerization treatments were lower than that for other tested groups. These finding is due to that the release of RM is a temperature-dependent process, thus increasing the temperature enhances the diffusion.

It has also been demonstrated that the fall in RM levels that takes place after polymerization is due to further polymerization at the sites of active radicals, and at

higher temperatures, monomer molecules should diffuse more rapidly to these active sites and the rate of fall in monomer levels should increase<sup>(20)</sup>.

### CONCLUSION

The conclusion of this study showed that microwave post polymerization treatment increase the transverse strength. And water bath and microwave post polymerization treatments decrease the residual monomer of auto polymerized acrylic resin

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