

Evaluation of Effect of Three Different Solutions on Impact Strength of Heat Cured and Micro Wave Cured Denture Base Resin-In Vitro Study

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Abstract: Background: The aims of this study to evaluate and compare the impact strength of heat cured and micro wave cured denture base resin after immersing in different fluids routinely used in day to day life. **Methods:** A total number of 160 samples were prepared with dimension of 65x10x3mm..Out of which 80 samples were prepared from heat cured acrylic resin (group A) and the other 80 samples were prepared from micro wave cured resin (group B).Each category again divided into four sub groups as follows sub group I, II, III, IV. Impact strength of the acrylic resin was measured by charpy's test. **Result:** Data analyzed by using SPSS software with ANOVA test followed by Tukey HSD test indicated that p-value less than 0.01 denotes significant difference at 1% and 0.005 at 5% between the four subgroups. **Conclusion:** Micro wave cured resin has better Impact strength values than heat cured resin in all sub groups and within the sub groups specimen immersed in Aerated drink has the lowest impact strength.

Key Words: Impact strength, heat cured resins, microwave cured resins

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I. Introduction

The poly methyl methacrylate was introduced by Dr. Walter, Wright¹ and the Vernon brothers in 1937 which is then brought about improvement in denture construction with good esthetics, dimensional stability, ease of processing and accurate fit.^{1,3} Since then poly methyl methacrylate resin polymers made a remarkable improvements in the construction of denture bases, 95% of all dentures are now constructed by poly methyl methacrylate polymers.^{2,3}The excellent working characteristics of poly methyl methacrylate made its usage as a wide open in the Dental and Medical field.

The presence of Saliva and Oral fluids and the oral consumption of the individuals may have their impact on the denture base and tooth. Variations of P^H and temperature of these fluids have been considered as the causative factors. They have a tendency to interfere or weakened the chains which are already formed by means of polymerization.^{4,5}Solubility is the soluble substances leached out during storage in water and in the oral fluids. The phenomena of sorption and solubility producing deleterious effects. These effects may include volumetric changes such as swelling, physical changes such as plasticization and softening, and chemical changes such as oxidation and hydrolysis.^{4,5,6,7}

The effect of various beverages and medicaments has not been studied in detail in the past. Keeping this as a background this in vitro study is proposed with following aims and objectives.

II. Materials And Methods

Preparation Of The Samples & Grouping:

A total number of 160 samples were prepared with dimension of 65x10x3mm according to ISO specification (1567). Out of which 80 samples each were prepared from heat cured acrylic resin (group A) and micro wave cured resin (group B). Each group were again divided into four sub groups as I, II, III, IV. The sub group I samples were used as control group. Forty samples were allotted for testing specimens out of which 20 samples were taken up from (group A) and (group B).

PREPARATION OF TEST SAMPLES

A rectangular steel die was milled from a metal blank measuring 65 mm x 10 mm x 3 mm in length breadth and thickness respectively to simulate the bar (Fig-1). This steel die bar was used to create a stone mold by investing in a type III dental stone (Fig-2). According to manufacturer's instructions powder and liquid were taken in a ratio of 3:1 by volume. Then the mix was thoroughly mixed and the resin were packed into the molds by compression molding technique⁸. Samples of resin were cured at 70 degree centigrade for one and half hours followed by terminal boiling for one hour. After processing all of the flasks were allowed to bench cool for 30 minutes.

For micro wave cured resin the stone mold with wax pattern was invested in a plaster and stone mix 50% of each according to manufacturer's instructions in a polycarbonate flask reinforced with fiber glass⁹, dewaxing was done in microwave oven at 750 watt for a period of one minute. After bench cooling for ten minutes, the isolant was applied over the mold space.¹⁰ According to the manufacturer's instructions 23.5gms of powder and 10 ml of liquid were taken and resins were packed into the molds with 2 bar/pressure after trial packing the screw was tightened.¹⁰ For curing polycarbonate flask was kept in oven for nine minutes at 750 Watts.¹¹ After deflasking the rectangular resin samples were retrieved from the mold and immersed in distilled water at $37 \pm 1^\circ\text{C}$ for 50 ± 2 hours for residual monomer release.¹² The specimens were trimmed using stones, trimmers and finished with specific dimensions as specified by ISO specifications (Fig-3). The exclusion criteria for the samples were specimens with smaller dimensions, internal porosity, external porosity, and surface defects.

Preparation Of Staining Solutions

The coffee solution was prepared by adding 20g of coffee powder (Nestle India LTD.) into 1000ml of boiled water. Aerated drink (Hindustan Coca cola Beverages Private LTD, India) and Chlorinated water are poured into separate jar and the acrylic specimens fabricated were immersed in the solutions respectively as per the table (I). The table 1 showing immersion media used in the present study showing the quantity generally used for single use, approximate time spent for single use and the duration adopted which is equivalent to three years¹³. After immersion the specimens were then subjected for Impact strength. Impact strength of the acrylic resin was calculated using 300 joules capacity impact testing machine (Notched Impact Tester ASTM D-256, Tinius Olsen USA) (Fig-4). Impact strength was tested by the Charpy system. When the hammer of the impact testing machine hits the specimen, reading at which the specimen breaks gives the impact strength it is the pendulum type and the impact strength values were obtained directly in the machine scale. The mean values were subjected to statistical analysis.

III. Results

Data were analyzed by SPSS 16.000 software and the results were obtained (Table 2,3 and 4) and Bar diagram (1).

One-way analysis of variance (ANOVA) was used to determine statistical differences among the impact strength of two groups followed by inter group comparison which was done using multiple comparison post hoc TUKEY HSD. To find significance paired T test between the groups were used.

Table 1 shows that the specimens immersed in aerated drink has the lowest Impact strength value followed by coffee, chlorinated water and control sub group in increasing order. Table 2 and 3 shows Comparison of the Impact Strength of sub groups of heat cured and micro wave cured resin using Tukey HSD Post Hoc Tests comparison at a significance level of 1% and 5% shows that the specimens immersed in aerated drink has deleterious effect than other sub groups with denture base resins. From the results and the statistical analysis it can be inferred that micro wave cured resin has better Impact strength values than heat cured resin in all sub groups and within the sub groups specimen immersed in Aerated drink has the lowest impact strength.

IV. Discussion

In conventional heat cure method, the monomer molecules are moved by thermic shocks they receive from other molecules, polymerization has to be conducted at a lower temperature for a long period of time. This low temperature curing takes longer time to convert the monomer to polymer and to complete the polymerization.¹⁴ while in microwave energy method a form of self-regulation of the curing program takes place and leads to the complete polymerization of the resin. Within a short period of time when compared with heat cured resin.¹⁵ There is almost no thermic inertia, which permits good control over the resin temperature and allows for curing at a strictly controlled low temperature.^{16,17} The change in the impact strength parameters recorded on statistical analysis show influence of carbonated beverage solutions on the denture base resin. The presence of phosphoric acid may have to be considered as causative factor which acts as a the plasticizer and

causes the changes in the impact strength. The mean values for groups A and B stored in beverage showed decrease in impact strength in this study. This decrease in strength may be due to the hydrolysis of bond between molecules by beverage. The development of stress concentration and entrapment of air at the bond interface area weakens the impact strength. This result may be attributed to the acidic nature and basic composition of beverage which cause the hydrolysis of poly methyl methacrylate. There is definite influence of Pepsi solution on poly methyl methacrylate resin where there was no significant difference in tensile bond strength, for all test specimens stored in water while there was highly significant difference for the test specimens stored in Pepsi.¹⁸ PMMA contains ester groups which easily hydrolyze in acidic pH which convert methacrylate to carboxylate and alcohol. The first step in the reaction involves the attachment of oxygen atom of carbonyl group with the proton (acidic hydrogen), in this step there will be an increase in the electrophilicity of the carbon of the carbonyl group then the attachment of nucleophile (HO) group forms carboxylic acid and alcohol. This could be attributed to the decrease in the impact strength.

V. Conclusion:

Within the limits of the in vitro study and from the results following conclusions can be made

1. Micro wave cured resin has showed a significant increase in Impact strength when compared to heat cured polymerization.
2. The specimen immersed in aerated drink has more deleterious effect on the impact strength of samples of heat cured and micro wave cured acrylic resins and it is followed by coffee and chlorinated water.

In any laboratory study, the samples used cannot be simulated biological structures exactly. This in vitro study was attempted to evaluate the mechanical property of the denture base resin with two polymerization methods after immersion in different liquid media routinely used in day to day life. More emphasis has to be put forward to clinically evaluate the same. Among the oral intake of individuals wearing prosthetic appliances such as partial and complete dentures the aerated drink was found to be more deleterious than other substances

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Figures With Legends



FIG- 1 STEEL METAL DIE



FIG- 2 FLASKING RESIN SPECIMEN



FIG-3 FLASKING RESIN SPECIMEN



FIG-4 CHARPY IMPACT TESTER

Tables

Table (1) DARATION of Immersion solutions used in this study

Solution	Amount consumed /day	Approx. time spent/dose	Duration equivalent to 3 years
Chlorinated water	1 litre	1 min	18 hours
Coffee	120 ml	3 min	55 hours
Aerated drink	300 ml	5 min	91 hours

Table (2) : shows the p value using ANOVA test for group A& B for Impact strength :

GROUPS	SUBGROUPS	N	MEAN	SD	F RATIO	P-Value
	Control	20	26.35	2.97	24.799	<0.001**
	Chlorinated water	20	24.58	1.41		
	Coffee	20	24.55	1.88		
	Aerated Drink	20	18.50	2.15		
GROUP B (Micro wave cured Resin)	Control	20	30.14	1.69	6.442	<0.001**
	Chlorinated water	20	28.62	6.59		
	Coffee	20	28.45	1.30		
	Aerated Drink	20	23.58	1.53		

N = No. of Samples, p-value-Significant(*) - <0.05, Highly significant(**)-<0.01

Table (3) shows Comparison of the Impact Strength of sub Groups in Group A and Group B using Tukey HSD Post Hoc Tests

GROUPS	SUBGROUPS COMPARISON	Mean Difference	95% Confidence Interval		P-Value
			Lower Bound	Upper Bound	
A	Control Vs Chlorinated water	1.7695	-0.856090	4.395150	0.283
	Control Vs Coffee	1.7963	-0.829280	4.421960	0.271
	Control Vs Aerated drink	7.845	5.219530	10.470770	<0.001**
	Chlorinated water Vs Coffee	0.026810	-2.598810	2.652430	1.00
	Chlorinated water Vs Aerated Drink	6.0756	3.450000	8.701240	<0.001**

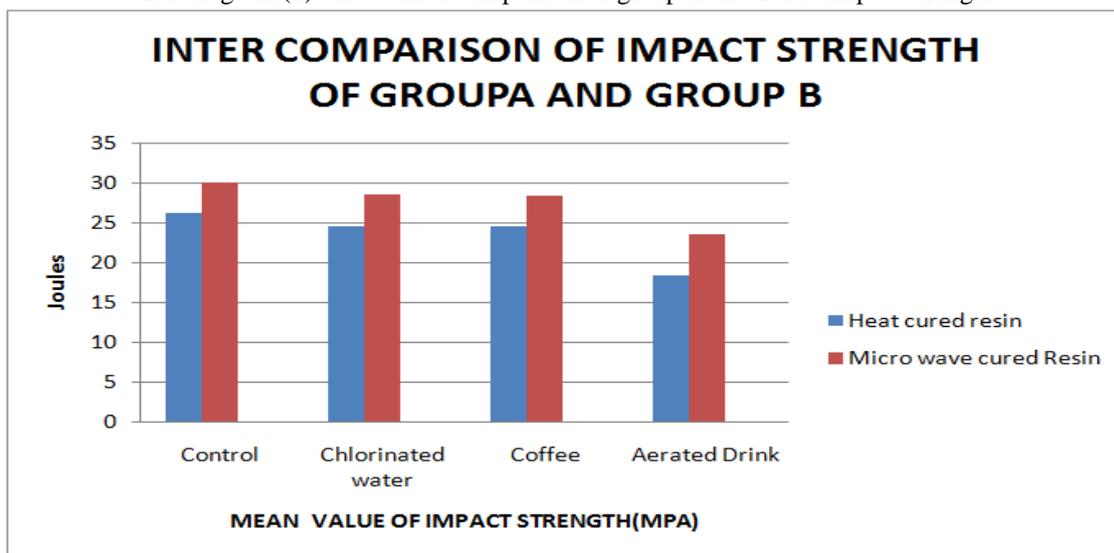
	Coffee Vs Aerated drink	6.0488	3.423190	8.674430	<0.001**
B	Control Vs Chlorinated water	-0.16346	-4.434978	4.108058	1.00
	Control Vs Coffee	-1.6916	-5.963208	2.579828	0.712
	Control Vs Aerated drink	4.8666	0.595142	9.138178	0.020*
	Chlorinated water Vs Coffee	-1.5282	-5.799748	2.743288	0.771
	Chlorinated water Vs Aerated Drink	5.0301	0.758602	9.301638	0.016*
	Coffee Vs Aerated drink	6.5583	2.286832	10.829868	<0.001**

* The mean difference is significant at the .05 level.

** The mean difference is significant at the .01 level.

Bar Diagram

Bar diagram (1) shows inter comparison of group A and B for Impact strength



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