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Evaluation the Compressive Strength of Two Types of Self Cure Acrylic Resin (With &Without Cross-Linking Agent) Processed Under Different Degrees of Pressure

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Abstract
Both of the mechanical and physical qualities of the acrylic resin can be affected by the pressures since they have a direct effect on the chemical reaction that occurred during the polymerization. The aim of this study was to examine the compressive strength features of the basic materials for self-cured acrylic resin dentures using several pressure modalities to be then compared with those polymerized under a pressure of 30 psi. Fifty self-cured acrylic resin specimens have been collected in two main groups (25 specimens without cross-linking and 25 specimens with cross-linking). From each main group, 5 specimens that polymerized in water at 37°C under 30 psi pressure were used as a control group, and the other specimens polymerized in water at 37°C under 25 psi, 50 psi, 75 psi, and 100 psi pressure as four experimental groups, with 5 specimens prepared for each group. The results showed that the self-cured acrylic resin with a cross-linking agent gives higher compressive strength than the self-cured acrylic resin without a cross-linking agent. Additionally, the compressive strength of two self-curing acrylic resin versions (with and without cross-linking) decomposed in water at 37 degrees Celsius under (50 psi, 75 psi, and 100 psi) pressure was improved compared with that processed at 30 psi pressure (control group); at the same time, the specimens that polymerized at (100 psi) pressure showed a highly significant increase in the compressive strength compared with both the control group and other experimental groups. While 25 psi was reduced compressive strength at these pressures in comparison to control groups. Finally, one can draw a conclusion stating that the processing pressure and the type of acrylic resin can be considered as important factors in improving compressive strength property.

Introduction:

In dentistry, self-cured acrylic resin can be regarded as one of the most prevalent materials used for repairs, relines, orthodontic appliances, and maxillofacial prostheses, in addition to crown and bridge work, as a temporary coverage of prepared teeth[1- 4].

The use of self-cured acrylic resin in prosthetics is related to its simple technique at room temperature, less time-consuming, and less equipment required [5]. It is extremely important to recognize the physical and mechanical attributes of the materials used in dental care. First, the oral environment and biting forces can damage the materials used to restore the missing tooth tissue. Secondly, a number of preventative measures are followed to clean and polish the restorative materials. Hence, the selecting a material for certain oral surgeries and restorations is highly dependent on their qualities [6].

Soaking a temporary resin in hot water is a well-known technique and is usually advised by the manufacturer since heat stimulates the chemical reaction of acrylic resin [7]. The main objective of this study was to evaluate and compare the compressive strength of two self-curing acrylic resin versions released at various temperatures (with and without a cross-linking agent) in addition to having a chance to test the impact of different degrees of pressure during polymerization (25 psi, 50 psi, 75 psi, and 100 psi) on the compressive strength of self-cured acrylic resin.

Materials and Methods:

Specimens grouping:

Pink cold-cured acrylic resin denture base materials have been used for producing fifty specimens, which were subsequently separated into two distinct categories of 25 each. ten groups of specimens were used in the current study, varying in type of acrylic resin with and without cross-linking and pressure conditions. As seen in Figure (1), there are just five samples in each of the groups.

Metal pattern preparation

As seen in Figure (2), a carbon steel cylinder metal pattern measuring 12 mm by 6 mm in length and diameter has been manufactured in compliance with [8] in order to conduct compressive strength tests .

Mould Preparation:

The flask was then cracked open, and metal patterns were carefully taken out of the mould using a traditional denture flasking method [9].

The directions provided by the manufacturer (3:1) for blending the volume of pink cold-cured acrylic (Vertix, Netherlands) have been carried out. After placing the liquid in a dry and clean mixing vessel, the powder was added little by little. The combination was afterwards stirred with a wax knife, and allowed to stand in a sealed container at room temperature (23°C ± 5°C) till it attained its dough state.

The acrylic resin dough was used when it did not stick to the vessel wall. It was packed in the mould, which had been treated with separating medium with the aid of a polythene sheet. Following the sealing process of the flask, the two halves were set under a hydraulic press. The pressure was gradually raised allowing the dough to flow equally within the mold cavity. The flask was then opened after the release of the pressure, and a sharp knife was used to remove away the extra fluid that had spilled around the mould cavity. The polythene layer was taken out after completing a second trial closure, and the plaster surface was once more treated with separating media before being allowed to dry. After making intimate contact, the two sides of the flask were eventually sealed and put under the press for five minutes [10]. The flasks required for preparing the first set of samples (groups A and B) or control groups were placed in the ivomat curing equipment with water at 37°C and 30 psi of air pressure for a quarter of an hour.

However, producing the second groups of specimens requires the flasks to be likewise moved to an ivomat filled with water at 37°C and cured for fifteen minutes at multiple pressures (25, 50, 70,

and 100 psi). Once the curing process was finished, the flask was let cool gradually for half an hour at room temperature. The plaster mould was then cleansed of the acrylic patterns. An acrylic and stone bur served to polish all of the acrylic resin samples, and then a smooth surface was achieved by using a120-grain sandpaper while continuously cooling with water to avoid overheating. A dental lathe polishing machine was used to polish the surface applying a bristle brush and pumice at a low-speed of 1500 rpm until a shiny look was achieved. A Vernier was the tool used to get the final measurement.

Compressive strength

A: Test Specimens:

As illustrated in Figure (3), the acrylic resin was manufactured for compressive strength testing using a carbon steel cylinder metal pattern that measured 12 mm by 6 mm in length and diameter.

B: Testing Procedure:

The compressive strength was determined using the initial cross-sectional area of the sample and the maximum force applied during a compression test, based on American stander tests of materials (ASTM) [11]. The compressive strength was evaluated using the compression test instruments along with grips designed specifically to hold the test sample. A chart speed of 20 mm/min is set with a cross-sectional area head speed of 2 mm/min.

The force at failure was measured in kilogr ams, which was then transformed into N[12] using a compressive load with a maximum capacity of 2500 kg.

The following formula, as per[13] , was use d to determine the compressive strength values.

C.S. = F/ DH

C.S = Compressive strength (N/mm^2).

h = Height of the specimen (mm).

F = Force at failure (N).

d = Diameter of the specimen (mm).

Statistical Analyses:

Suitable statistical methods were used in order to analyze and assess the results; they include the followings:

1. Descriptive statistics:

Summary statistics of the reading's distribution (mean, SD, SR, minimum and maximum). Graphical presentation by (bar – charts).

2. Inferential statics: These were used to accept or reject the statistical hypotheses, and include one-way analysis of variance (ANOVA)test with multiple comparison (LSD) test "least significant differences test". The mean difference is significant at the 0.05 level.

Results

The compression strength of the self-cure acrylic processed in water at 37°C under 30 psi pressure (control group) and in water at 37°C under various pressures (25 psi, 50 psi, 75 psi, and 100 psi) is shown in the following sections using both descriptive and inferential statistics.

Based on the results illustrated in Table (1), acrylic resin with and without cross-linking had the lowest mean compressive strength values (23.811 kg) at 25 psi, whereas acrylic resin with and without cross-linking had the greatest mean values (49.725 kg, 45.495 kg) at 100 psi, Furthermore, the compressive strength mean values of acrylic resin with cross-linking of the tested groups were clearly greater than the compressive strength mean values of acrylic resin without cross-linking of the tested group Figure(4).

There was a significant difference ($p<0.05$) in favor of acrylic resin with cross-linking, as determined by findings of the way ANOVA with LSD of multiple comparison tests. Moreover, the results of multiple comparison tests among several tested groups are presented in Table (2), showing a highly significant difference between the control group (A1) and (A2, A3, B1, and B2), between (A2 and B2), between (A3 and (A4, B1, B2, and B3), between (A4 and (B1 and B2), between (B1 and B5), between (B1 and B2), between (B3 and B4), and between (B4 and B5).

Discussion

Despite having fewer desirable qualities than heat-cure acrylic, self-cure acrylic remained commonly used. This research studied the application of various levels of pressure for curing the self-cure acrylic resin with and without cross-linking considering many efforts made on enhancing its qualities. The results of the current study demonstrated a highly significant growth in the compressive strength values of the self-cured acrylic resin as compared to those of the control and other experimental groups, similar results were obtained by Craig and McCabe [14,15] .

The effect of different degrees of processing pressure:

As stated by AL-Kafaji and Craig et al., [5, 6], the high compressive strength values in samples under pressure (50, 75, and 100 psi) as compared to the control group may be attributed to less stretch of the acrylic resin and stability of molecular weight.

While the possible explanation for the reduction in compressive values in samples under pressure(25Psi) when compared to control groups and othe r experimental groups may be due to high water sorption in specimens polymerized at this degree of pressure, it could increase the space between the molecular chains which may be lower the compressive strength , this is in agreement with Al-Gaban [9], other explanation could be related to the presence of porosity in the specimens cured at this degree of pressure, this is agreed with AL-Kafaji and Ray [5, 16] , who found that if the porosity reaches the surface the compressive strength will be lowered.

The effect of cross linking agents:

The differences between acrylic resins used in this study is based on the presence of cross-linking agent, the acrylic resin with cross-linking agent showed the highest compressive strength at (P value <0,5). These results indicated that cross-linking agent had increased the compressive strength significantly, this is supported by Craig and others[14,17- 19] they explained that the cross linking acrylic resin have more polymer chains compared to acrylic resin without cross-linking agent.

Conclusion:

Within the limitations of the present study, the acrylic resin without cross-linking lower compressive strength compared with the acrylic resin with cross-linking, and had been emphasized statistically with significant difference between them. The 50psi, 75psi, and 100psi had improved significantly compressive strength. In 100psi produce the higher compressive strength in both types of acrylic resin (with and without cross linking agent), while in 25psi produce lesser compressive strength in both types of acrylic resin (with and without cross linking agent).

Conflict of interest

The authors have no conflicts of interest to declare.

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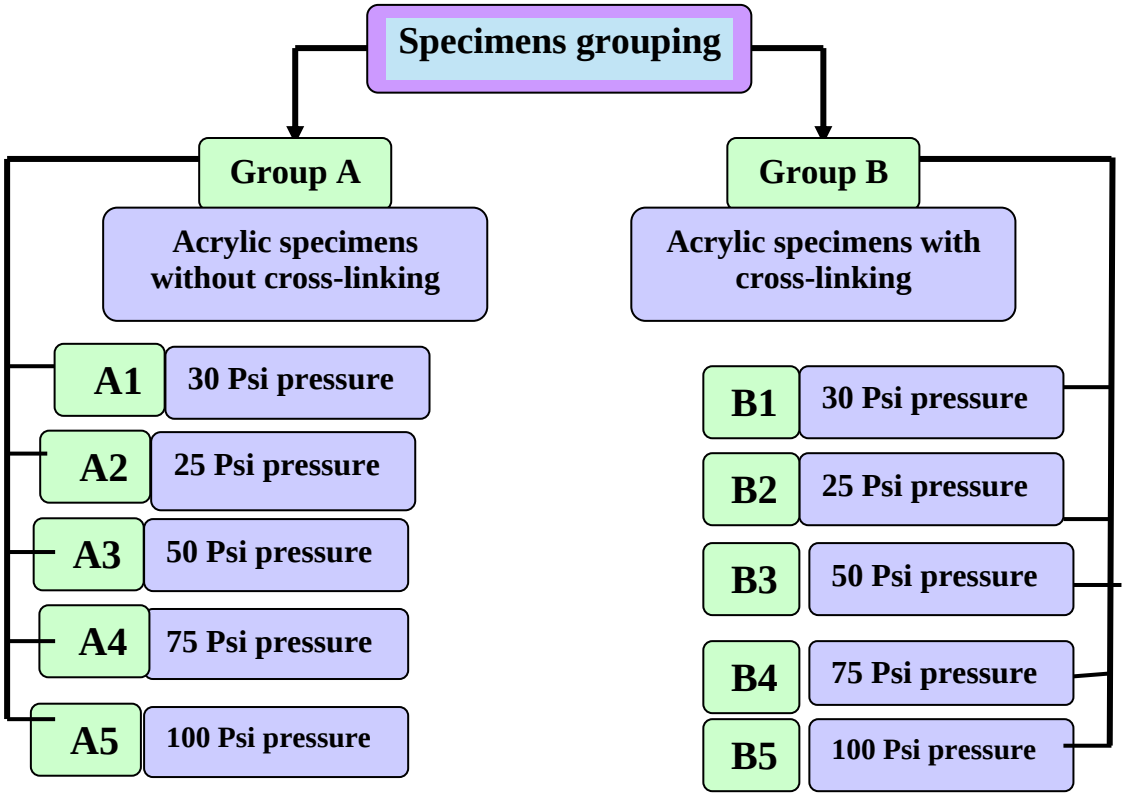

Figure (1): A diagram illustrates the design of study

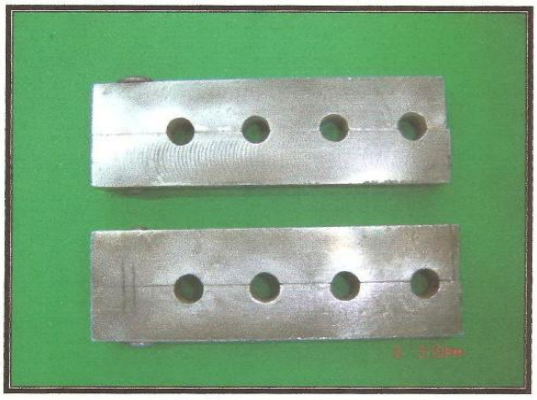

Figure (2): Metal patterns for Compressive strength test

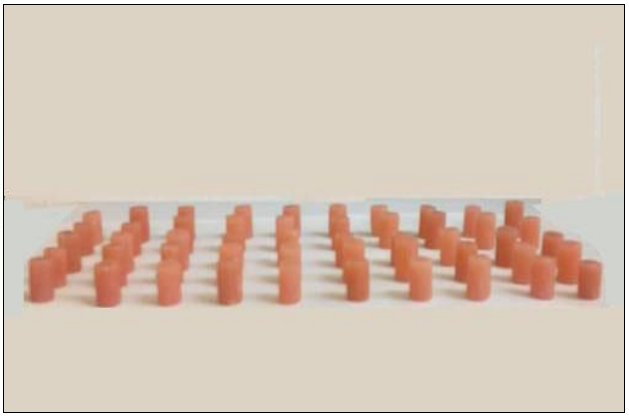

Figure (3): Tested specimens for Compressive strength test.

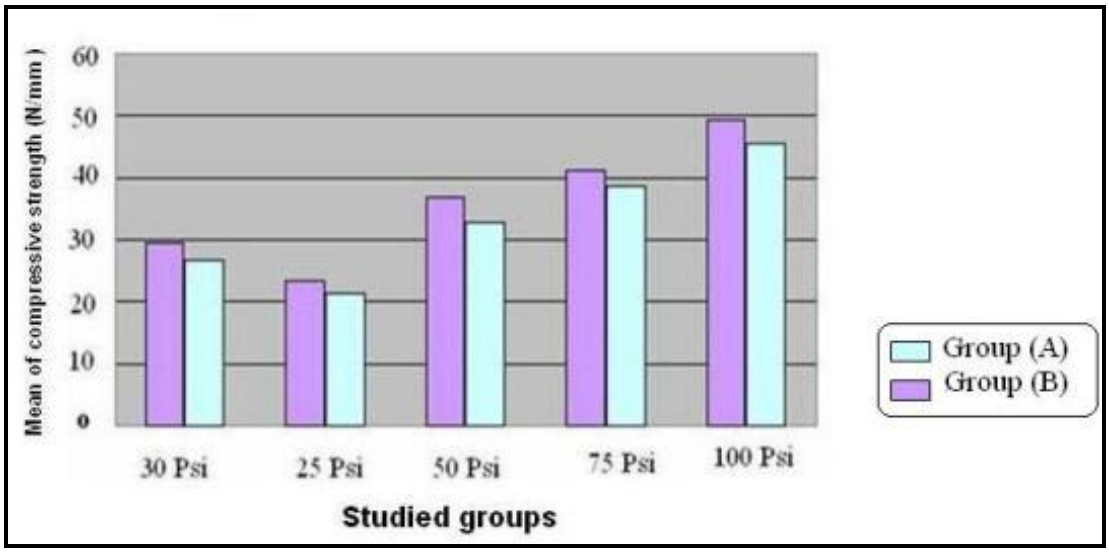

Figure (4): Bar chart for compressive strength property of the self-curd acrylic resin denture base materials.

Table (1): Compression strength of the self-cure acrylic resins denture base denture base with and without cross-linking as influenced by different degrees of pressure.

Studied groups	Statistics	Control Groups*30psi	25psi	50psi	75psi	100psi
Group -A- without cross linking	mean	26.796	21.41	32.822	38.7	45.445
	Max.	27.462	21.714	33.761	39.175	46.164
	Min.	25.798	20.864	31.872	38.206	44.826
	SD.	0.6345	0.326	0.8277	0.4386	0.4933
Group -B- with cross linking	mean	29.565	23.492	36.929	41.303	49.205
	Max.	30.105	23.811	37.215	41.731	49.725
	Min.	28.911	22.952	36.422	40.46	48.719
	SD.	0.4396	0.3495	0.3272	0.5	0.3961

Table (2): Multiple comparison test (LSD) of compression strength between tested groups.

Studied Groups	Control*Group 30psi(A1)	25psi (A2)	50psi (A3)	75psi (A4)	100psi (A5)	Control* Group 30psi(B1)	25psi (B2)	50psi (B3)	75psi (B4)	100 psi (B5)
Control*Group 30psi(A1)		***S***	**S**	**HS**	**HS**	**S**	**S**	**HS**	**HS**	**HS**
25psi (A2)			**HS**	**HS**	**HS**	**HS**	**S**	**HS**	**HS**	**HS**
50psi (A3)				**S**	**HS**	**S**	**S**	**S**	**HS**	**HS**
75psi (A4)					**HS**	**S**	**S**	**HS**	**HS**	**S**
100psi (A5)						**HS**	**HS**	**HS**	**S**	**S**
Control*Group 30psi(B1)							**S**	**HS**	**HS**	**HS**
25psi (B2)								**HS**	**HS**	**HS**
50psi (B3)									**S**	**HS**
75psi (B4)										**S**
100psi (B5)										

S =(P<0.05) Significant difference.
HS =(P<0.01) Highly Significant difference.

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