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**EFFECT OF VARIOUS PROPORTIONS OF CALCIUM CARBONATE ON THE  
RADIO-OPACITY AND PROPERTIES OF SELF-CURE RESIN (PINK) - AN IN-  
VITRO STUDY**

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Received 19<sup>th</sup> March 2020; Revised 22<sup>nd</sup> April 2020; Accepted 14<sup>th</sup> May 2020; Available online 1<sup>st</sup> Oct. 2020

<https://doi.org/10.31032/IJBPAS/2020/9.10.5292>

**ABSTRACT**

**Aim**

To evaluate the radiopacity and properties of self cure acrylic resin in combination with  
different proportions of calcium carbonate.

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## Materials and methods

A total of 27 samples of self cure acrylic resin (pink colour DPI- RR) was fabricated of the size 4 X 3 X 3 mm. Three samples were present to each group. Calcium carbonate was added in various proportions to the three groups. Independent variables were the powder to liquid ratios. Dependent variables were the dough forming time, setting time, compressive strength and radio-opacity.

## Results

Maximum radio-opacity was seen in 3:1 P/L with maximum calcium carbonate in all the different powder liquid ratios. Compressive strength increased after addition of calcium carbonate.

## Conclusion

The results of the present study conclude that calcium carbonate provides evident radiopacity to the self cure acrylic resin. Furthermore, the concentration of calcium carbonate also affects the intensity of radiopacity. It was found that higher concentrations produce a higher degree of radiopacity.

**Keywords: Self-cure acrylic resin (pink), calcium carbonate, radiopacity, compressive strength, dough forming time**

## INTRODUCTION

Acrylic resins are the most commonly used material in dentistry. Its advantages are economy, simplicity in processing, stable colours, optical properties, adequate strength and other physical properties which make them desirable materials of choice [1]. To overcome the drawbacks of mechanical properties of the resin, there have been new advancements in the field of self-cure resins. Resins have been reinforced using different materials to improve strength and other mechanical properties [2, 3].

Removable appliances such as full and partial dentures, bite splints, night guards

and the like have the potential to be accidentally dislodged and find their way into the body, requiring surgical removal. The American Dental Association and several dental journals regularly receive reports of such incidents and pleas are often heard for the use of radiopaque materials to facilitate the retrieval of impacted dental objects.

The requirement for radiopacity in dental resins was fully documented by a recent report prepared for the ADA Council on Dental Materials [4]. There is not enough scientific evidence on the radio opaque properties of self-cure resins. Various

additives like barium, titanium, strontium have been added to the resins to improve most of these drawbacks [3, 5].

The main aim was to evaluate the radiopacity of self-cure acrylic resin on addition of different proportions of calcium carbonate in all the P/L ratio of the resins. The second objective of this study was to evaluate the mechanical properties of self-cure acrylic resin (pink colour DPI-RR Cold Cure).

### **MATERIALS AND METHODS**

In this study, three samples were fabricated of each the control and the test group, in three different ratios of powder: liquid of self-cure acrylic resin (pink colour DPI- RR self-cure). A total of 27 samples were used for this study. The independent variables were the 3 P/L ratios. The dependant variables were the Compressive strength, Dough forming time, Setting time and Radio-opacity.

The compressive strength was measured using hydraulic press (Sirio P400 Hydraulic Press), in psi (pounds per square inch). The radio opacity was evaluated by incorporation of calcium carbonate in the resin in 2 different amounts, 500mg and 1000mg. The radiopacity was measured by taking radiographs of the sample. The dough forming and setting time were

evaluated by measuring time taken to form dough stage and time taken for initial set respectively.

### **PROCEDURE**

A block of size 4 X 3 X3 mm was fabricated using dental plaster and an index of the block was made using elastomeric impression material (putty) (**Figure 1**). This mould was used to standardize and fabricate self-cure acrylic blocks of standardised dimensions for the study.

These blocks were fabricated using 3 different P/L ratios. The control group (Group B) had the powder liquid ratio of 3:1 as recommended by the manufacturer. Group A had an increased amount of powder with a P/L ratio of 4:1 and Group C had increased monomer content with a P/L ratio of 3:2. The samples were allowed to cure according to the standard manufacturer's recommendation (**Figure 2, 3, 4, 5**).

The following were the sample groups.

#### **SAMPLE GROUPS:**

**GROUP A: 4:1 P/L (test group)**

**GROUP B: 3:1 P/L (control group)**

**GROUP C: 3:2 P/L (test group)**

**GROUP B+: 0.5 g CaCO<sub>3</sub> IN 3:1 P/L of resin**

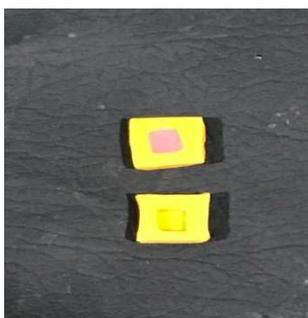
**GROUP B++: 1 g CaCO<sub>3</sub> IN 3:1 P/L of resin**

**GROUP A +: 0.5 g CaCO<sub>3</sub> IN 4:1 P/L of resin**

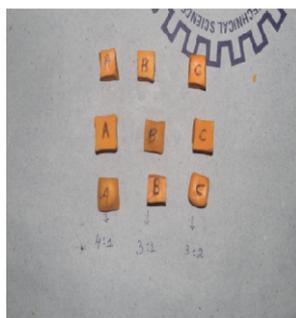
**GROUP A ++: 1 g CaCO<sub>3</sub> IN 4:1 P/L of resin**

**GROUP C +: 0.5 g CaCO<sub>3</sub> IN 3:2 P/L of resin**

**GROUP C ++: 1 g CaCO<sub>3</sub> IN 3:2 P/L of resin**



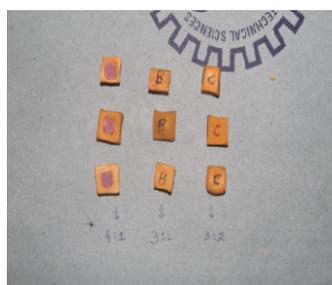
**Figure 1: Formation of the putty Index for sample fabrication**



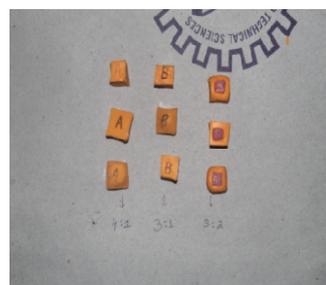
**Figure 2: Putty moulds of the 3 groups**



**Figure 3: Group A: 4:1 P/L ratio (Test group)**



**Figure 4: Group B: 3:2 P/L Ratios (Control group)**



**Figure 5: Group C: 3:2 P/L Ratios (Test group)**

## RESULTS

The mechanical properties of self-cure acrylic resin was studied (**Figure 6**). The mechanical properties of the three samples named as A, B and C with powder liquid ratio of 4:1, 3:1 and 3:2 respectively (**Table 1**). The sample B is the control group and the P/L ratio this sample is taken according to the manufacturer's instructions. Sample B showed maximum compressive strength. The sample A, B, C was taken and calcium carbonate was added separately. The mechanical properties of the set material were observed for its radiopacity (**Figure 7**).

Sample A+ consisted of 4:1 P/L ratio resin and calcium carbonate of 500mg. Sample

A++ consisted of 4:1 P/L ratio resin and calcium carbonate of 1000mg (**Table 2**). Sample B+ consisted of 3:1 P/L ratio resin and calcium carbonate of 500mg. Sample B++ consisted of 3:1 P/L ratio resin and calcium carbonate of 1000mg (**Table 3**). Sample C+ consisted of 3:2 P/L ratio resin and calcium carbonate of 500mg. Sample C++ consisted of 3:2 P/L ratio resin and calcium carbonate of 1000mg (**Table 4**). The maximum compressive strength was shown by group B++ (3:1) with 190 psi strength. The maximum setting time and dough forming time was shown by Group C ++ (3:2 P/L). Maximum radio opacity was shown by Group B++ (3:1 P/L).

Table 1: Mechanical properties of samples of self-cure acrylic resin in different P/L ratio

SAMPLE	P/L RATIO	DOUGH FORMING TIME	SETTING TIME	COMPRESSIVE STRENGTH
A	4:1	1:34 MIN	4:43 MIN	150 Psi
B	3:1	2:16 MIN	5:56 MIN	180 Psi
C	3:2	4:46 MIN	6:44 MIN	125 Psi

Table 2: Sample A+ consisted of 4:1 P/L ratio resin and calcium carbonate of 500mg

SAMPLE	P/L RATIO	DOUGH FORMING TIME	SETTING TIME	COMPRESSIVE STRENGTH
A+	4:1+CaCo3(500mg)	1:05 min	4:40 min	130 psi
A ++	4:1+CaCo3(1000mg)	1:30 min	5:00 min	150 psi

Sample A++ consisted of 4:1 P/L ratio resin and calcium carbonate of 1000mg

Table 3: Sample B+ consisted of 3:1 P/L ratio resin and calcium carbonate of 500mg

SAMPLE	P/L RATIO	DOUGH FORMING TIME	SETTING TIME	COMPRESSIVE STRENGTH
B+	3:1+CaCo3(500mg)	1:30 min	5:01 min	150 psi
B ++	3:1+CaCo3(1000mg)	1:47 min	5:32 min	190 psi

Sample B++ consisted of 3:1 P/L ratio resin and calcium carbonate of 1000mg

Table 4: Sample C+ consisted of 3:2 P/L ratio resin and calcium carbonate of 500mg

SAMPLE	P/L RATIO	DOUGH FORMING TIME	SETTING TIME	COMPRESSIVE STRENGTH
C+	3:2+CaCo3(500mg)	2:10 min	5:45 min	130psi
C ++	3:2+CaCo3(1000mg)	2:35 min	6:02 min	100 psi

Sample C++ consisted of 3:2 P/L ratio resin and calcium carbonate of 1000mg



Figure 6: Compressive Strength measurement



Figure 7: Radiograph in 3:1 ratio, radiograph of 4:1 ratio and radiograph of 3:2 ratio

## DISCUSSION

This study shows that altering ratios of acrylic resin had a significant influence on mechanical properties. On addition of calcium carbonate, the resin showed radiopaque properties, with the varying proportions used. Even after addition of this compound there was no clinically significant change in its mechanical properties measured in baseline.

With the results being obtained in this in-vitro study it was found that the maximum compressive strength was shown by group B++ (3:1) with 190 psi strength, the maximum setting time and dough forming time was shown by Group C ++ (3:2 P/L) followed by Group B++ which had the maximum radio opacity (3:1 P/L) [6]. This in vitro study mainly focuses on improving the properties of the widely used self-cure acrylic resin (pink) [3, 5, 7]. Acrylics are vinyl copolymers which contain as their principal monomers acrylates, methacrylate's, methacrylate's and/or their corresponding carboxylic acids, amides, nitriles and derivatives [8]. Being a thermoplastic material the PMMA self-cure acrylic resin should ideally possess the requirements such as adequate strength and resilience, should be ideally stable in all conditions including thermal conditions and various pressure on loading with a low specific gravity [9, 10].

Acrylic resins are mostly used as denture base material in dental practice. These are available in different forms according to the polymerization reaction as heat cure acrylic resin, rapid cure autopolymerising acrylic resin, light cure resin and specialized form resins used for microwave processing [10,11]. These materials have adequate strength to withstand the masticatory forces, maintains the dimensional stability, adequate resiliency, biocompatibility and high polish ability [12]. Resin is in two vials: one containing the powder, the polymer, and the other containing the liquid, the monomer. The monomer is a clear, flammable and volatile liquid at room temperature. It is considered cytotoxic and possibly genotoxic [13, 14]. The polymer usually has the pigment that gives colour to the resin [15, 16].

The results of this study show that the external addition of calcium carbonate does not degrade the mechanical properties of self-cure resin while simultaneously conferring the property of radiopacity. However, this experimental resin has not been tested in-vivo. In vivo studies are therefore required to evaluate the biologic response to this resin [17]. The material should be tested for toxigenic and leaching properties into tissues .There is an additional limitation in the form of small sample size for each group.

Studies also reported on the addition of calcium carbonate to improve rigidity of resins [18, 19]. The composition may include a small amount of a polymerization initiator and a small amount of a polymerization accelerator [20]. According to a study by Rune et al calcium carbonate modified with three surface modifying systems based upon stearic acid, acrylic acid and a reactive coating comprising acrylic acid with dicumyl peroxide through dry blending yielded tightly bound calcium acrylate [21]. Mejrinski et al had patented a corrosion resistant coating for metal surfaces curable with aciniticradiation . The blend uses an acrylate resin, photo initiator and corrosion preventing agent [22].

## CONCLUSION

According to the methodology used and the conditions established in this study, it can be concluded that:

1. Calcium carbonate provides evident radiopacity to the self-cure acrylic resin.
2. Furthermore, the concentration of calcium carbonate also affects radiopacity. It was found that higher concentration of calcium carbonate confers a higher degree of radiopacity.

The advantage of this being the ease of detection of the resin, radiographically, in case of accidental aspiration or ingestion.

The modified resin can also be used as radiographic stent in itself.

A limitation would be the small sample size test is this study. The advancement in dentistry has been possible through the cooperative efforts of contemporary scientists in many related fields. Each material has been extensively tested with newer modifications in order to improve their properties to achieve an ideal material intended for specific purposes.

## CONFLICT OF INTEREST

The authors declare there is no conflict of interest

## SOURCE OF FUNDING

Self-funded

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