

THE EFFECT OF CHEMICAL (GLUTARALDEHYDE) AND MICROWAVE STERILIZATION ON IMPACT STRENGTH OF AUTOPOLYMERIZING (PMMA) RESINS.

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ABSTRACT:

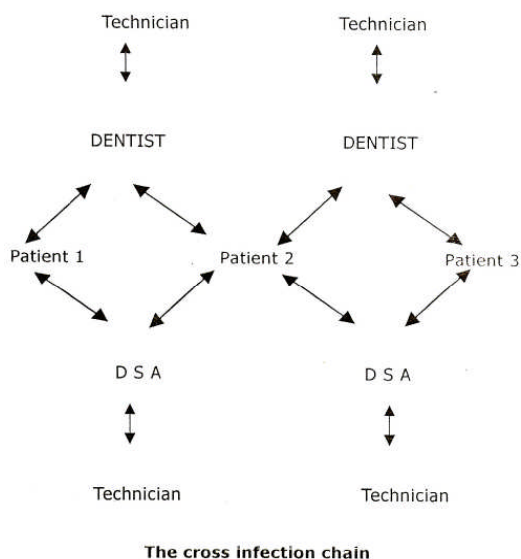
This study evaluated the effect of sterilization methods on the Impact strength of a self cured resins. A 10 hours immersion in 2 % alkaline glutaraldehyde, 15 minute exposure to microwaves energy was employed as a sterilization procedure. Storage in water for 10 hours was used as control. For each procedure 10 specimens were used. Results indicated that impact strength of the two groups did not change significantly as compared to control. Microwave sterilization can be opted as effective method and time saving procedure than immersion in chemical solution.

KEYWORDS: Micro-wave sterilization, Coding of Specimens ,Testing for Impact Strength

INTRODUCTION

Infectious diseases like AIDS, Hepatitis-B etc. alerted the public opinion to control these diseases during dental procedures. Sterilization of all items contaminated with blood and saliva practiced to avoid cross infection. In Prosthodontics potential source of Transmission of infection from patient to dental technician are impression, impression trays & Gypsum Casts^{1,2,3,4}.

In Addition the dental prosthesis at various stages of trial and insertion can transmit infections from dental staff to the patient. If proper measures are not taken cycle of cross contamination may occur exposing the dentist, dental staff and patient to transmission and acquisition of disease.⁵



Disinfection methods are less lethal than sterilization and are only used when sterilization cannot be carried out. The Concept of Universal instrumental sterilization, "if it can be sterilized, sterilize it"⁶ is valid – sterilization methods used in dentistry include^{6,7}

1. Heat

- Dry Heat (i.e. 160° c for 1 hour)
- Autoclave with steam at 121 ° c and 15 psi pressure for 30 minutes.
- Unsaturated Chemical Vapour (i.e. at 127 ° c and 25 psi for 20 minutes.
- Boiling water for 30 minutes.

2. Chemical

- liquid (i.e. immersion in alkaline Glutaraldehyde 2 % for 10 hours, immersion in 1 % solution hypochlorite for 10 hours)
- Gaseous (ethylene-oxide).

Other than Heat and chemical methods of sterilization is microwave energy. Rohrer and Bulard⁷ investigated the use of microwave energy for sterilization. They reported that microwave energy could be used for consistent sterilization and that aerobics spore forming micro organisms that are more resistant to sterilization could be eliminated with a 15 minute microwave energy exposure. They also reported that denture subjected to microwave energy were dimensionally identical before and after exposure.

Auto polymerizing PMMA Resin often used for a variety of applications in restorative dentistry.

1. Provisional Restoration (Temporary Crown & Bridge)
2. Special Trays for making secondary impressions
3. Fabrication of Temporary and Treatment Partially Dentures

Thermal methods of sterilization cannot be done for acrylic resins. Chlorine Treatment⁷ is effective, however rejected by the patient because of bleaching effect on the prosthesis.

The Effect of Glutaraldehyde and microwave disinfection methods on the dimensional stability, flexural properties and micro hardness of Heat cure acrylic resins was documented by Polyzosis GL and Zissis AJ⁸.

In this fast moving world time is most valuable, sterilization of dental instruments, prosthesis with chemicals for 10 Hours immersion may be difficult and sterilization with microwave energy of 15 min. is most attractive, effective and time saving.

This study is to investigate changes/ effects of Glutaraldehyde, Microwave sterilization on Impact strength of Auto polymerizing (PMMA) Resins.

Materials and Methods

The following materials and instruments have been used in this study.

I. Materials

1. **Group1:** self cure acrylic (tooth coloured) for temporization of crown and bridge in powder and liquid as supplied by *Dr. Jagdish Lal sethi, Wazipur India Limited*- under the brand name *SC-10*.
2. **Group2:** self cure acrylic repair resin denture base polymer resin in powder and liquid form as supplied by DPI – under the brand name of DPI-RR cold cure.

II. **Micro-wave oven:** DAEWOO make mode KOG 390A: 26 Liters.

Specifications:

Power output (Max.)	- 900 watt
Turn Table	- Glass
Interior	- Acrylic

III. **Disinfecting and sterilization solution 2.0**

% Glutaraldehyde w/v (1 Lt. Pack) with a separate activating powder supplied by *Johnson & Johnson* – under the brand name of *CIDEX*.

Testing Apparatus: *Pendulum Analogue:* (ASTMD 256 specifications) (Fig.1)

Impacto meter Model 1M.01 with accessories type charpy and notch cutter "*Norm-Kleinstab*" for notching of the specimens. (Fig.2)

Other miscellaneous materials and instruments

1. Rubber base impression materials (putty)
2. Glass measuring Jar
3. Glass measuring jar
4. Stainless steel spatula
5. Glass Plate
6. Digital weighing machine.

Preparation of the moulds:

For measuring impact strength:

One M-steel bar of uniform diameter of approximately 70mm length, 12mm width and 3mm of thickness was used to prepare the mould in silicon material (rubber base putty material).

Equal amounts of silicone impression materials are mixed and placed on a plastic tray and the M-steel bar placed on it and a glass slab is placed over it so that mold is formed of without distraction of the silicon material.

Preparation of Specimens for Impact strength:

Sixty self cured specimens were made. For each group ten specimens were made. Thirty specimens of tooth colored and 30 specimens of pink colored (repair material) were made.

The monomer-poly ratio was maintained at 2:3 by volume / weight for all groups. A pipette was used to transfer the required volume of monomer to a clean dry measuring jar. The polymer was measured by digital weighing machine and transferred to the dap-an-dish containing monomer. Thorough mixing was done with straight spatula. The mix was flown into the mould while tapping to avoid any air bubbles. A glass slab was placed over the mould to remove the excess material as flash, and to get a smooth surface. By the by the weight of the glass may act as pressure agent. The mold was allowed to polymerize for 10 minutes and the specimens were carefully separated from the mould. Set specimens were then trimmed for any excess borders with wheel stone and five graded sand paper.

Coding of Specimens:

Specimens prepared out of tooth colored are coded as

1. Specimens prepared with pink colored repair resin (pink) are coded as 2.



Fig. 1. Pendulum Analogue for measuring impact strength

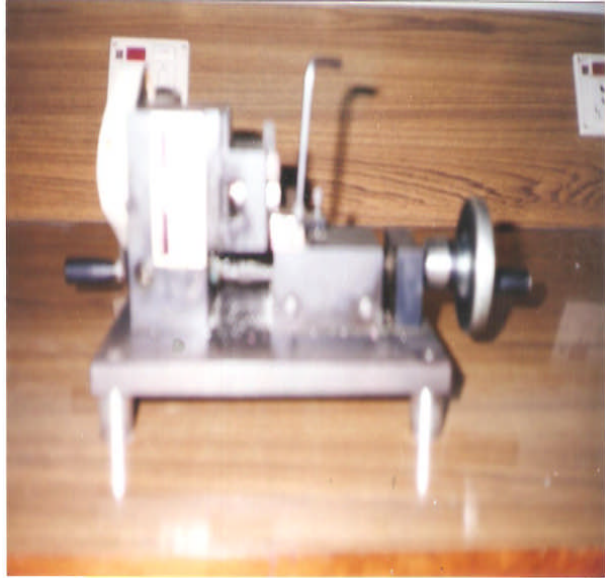


Fig.2. Notch Cutter "Norm-Kleinstab" for notching the specimens



Fig.3. specimen in 2% Glutaraldehyde (activated)



Fig. 4. Photograph showing specimens placed on the Turn table of oven along with the Borocil Bowl (filled with water)

With the tooth colored 30 specimens are made for testing impact strength coded as 1 Ai, 1 Bi, 1 Ci .

With the repair resin (pink colored) 30 specimens were made for testing impact strength. They are coded as 2 Ai, 2 Bi, 2 Ci, for impact.

A – Indicates control. (10 specimens each)
B- Indicates micro-wave sterilized.
C- Indicates chemical sterilized.

For each material, 10 specimens were used control. 10 micro-wave oven sterilization and 10 for chemical sterilization.

Control : The specimens used as control are placed in water for 10 hours. 1 Ai, 2 Ai each.

Chemical Sterilization: According to the manufacturer recommendation the 20 specimens are placed in the chemical solution for 10 hours.(**Fig.3**) 1 Ci, 2 Ci 10 specimens each.

Micro-wave sterilization:

20 specimens were placed in the micro wave on the turn table. For 15 minutes adjusted at 650 W power. A Borosil bowl filled with water was placed to protect the magnetron. 1 Bi, 2 Bi 10 specimens each.(**Fig.4**). A Borosil bowl with water placed parallel to the resin blocks to absorb heat generated to save the magnetron. There was exhaust provision also to drive out the heat generated by resin blocks during micro wave exposure. The micro wave energy was focused at an power adjusted to 650 watt. Continuously for 15 minutes.

The specimens were then removed from the oven and were ready for testing.

Testing for Impact Strength

Procedure:

The Specimen are placed on the support in a such a manner that the striking edge hits the centre of the specimen. Notched ball should be placed so that centre of the notch is located directly in the plain of impact, with a notch and rear side release the pendulum by depressing the release level and record the recording of the pointer on the scale to the nearest subdivision. Arrest and return the pendulum and release to its release position. Impact strength is calculated by

$$\text{Impact Strength} = \frac{\text{Impact energy absorbed (Joules)}}{\text{Average thickness of specimen (m)}}$$

Results

The Results of Impact Strength and their comparisons after microwave and chemical Sterilization in relation to control group are shown (**Table I and Table II**)

The Impact strength of sterilized specimens are compared with specimens stored in water for 10 hours. To obtain any significant differences between the data obtained for the groups of material tested. A one way analysis of variance (ANOVA) was undertaken.(**Table III and Table IV**)

The impact strength of two groups did not changed significantly when compared with control. ($P>0.05$). The lower and upper bounds are 3.4 J/m to 4.4 J/m.

Discussion

Infection control was given little attention prior to 1985 in prosthodontics⁵ when the ADA published “The Guidelines for the infection control in the dental office and the commercial dental laboratory” sterilization has become compulsory for any provisional restoration whether removable or fixed provisional restoration. Any sterilization method can be opted provided it should not effect the properties of the restoration.

The aim of this study is to determine effect of sterilization on the impact strength of two resins used for temporary bridge work and repair resin after chemical and microwave sterilization. Till 1985 chemical sterilization was only method for Acrylic, Rohrer & Bulard⁷ 1985 reported microwave energy could be used for consistent sterilization and that aerobic spores forming micro-organisms, the most resistant could be eliminated within a 15 min. microwave energy exposure, they also reported acrylic denture exposed to microwave energy were dimensionally identical before and after exposure.

According to ADA recommendations the sterilization can be achieved with chemicals in 10 to 12 Hrs. A Provisional restoration must fulfill several functions not least of which must be strong enough to resist fracture⁹. Tooth colored self cure resin is the material of choice for provisional coverage of teeth that have been prepared for fixed prosthodontic restoration¹⁰. Impact strength is one of the important properties of autopolymerizing resin.

Impact strength¹¹ is defined as the energy required fracturing a material under an impact force. A charpy-type impact test is usually used.

This test evaluated the effect of chemical and microwave sterilization on impact strength of Auto polymerizing PMMA Resin used for denture repair and provisional crown & Bridge restoration. Material used were Auto Polymerizing tooth colored (SC-10) and repair resin

Table.1 IMPACT STRENGTH OF TOOTH COLORED RESIN
(Mean & SD.Values by groups)

Groups	N	Mean	SD	Std. Error	95 % Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control (1Ai)	10	4.0110	0.4935	0.1561	3.6579	4.3641	3.29	4.43
Micro-wave (1Bi)	10	3.8860	0.4408	0.1394	3.5707	4.2013	3.51	4.42
Chemical (1Ci)	10	3.8130	0.4874	0.1541	3.4643	4.1617	3.15	4.42
Total	30	3.9030	0.4653	0.0850	3.7296	4.0771	3.15	4.43

Table.2 IMPACT STRENGTH OF REPAIR RESIN
(Mean & SD.Values by groups)

Groups	N	Mean	SD	Std. Error	95 % Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control (2Ai)	10	4.2280	0.3469	0.1097	3.9798	4.4762	3.57	4.48
Micro-wave (2Bi)	10	4.1990	0.3701	0.1170	3.9343	4.4637	3.48	4.42
Chemical (2Ci)	10	4.2040	0.3116	0.0985	3.9811	4.4269	3.60	4.39
Total	30	4.2103	0.3319	0.0606	4.0864	4.3343	3.48	4.48

Table.4. A one way analysis of variance (ANOVA) for repair resin

PARAMETER	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	4.807E-03	2	2.403E-03	0.020	0.980
Within Groups	3.190	27	0.118		
Total	3.195	29			

Table.3. A one way analysis of variance (ANOVA) for tooth coloured resin

PARAMETER	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	0.201	2	0.100	0.445	0.645
Within Groups	6.079	27	0.225		
Total	6.279	29			

Pink colored (DPI). Samples were prepared according to ASTM Standard specimens were prepared as 63 x 12 x 6 mm.

For Chemical sterilization samples were kept in vessel containing 2% Glutaraldehyde (Cidex) along with activator, for 10 Hrs as recommended by ADA. For microwave sterilization specimens were kept on the turn table of microwave oven adjusted to 500 Wt for 15 Min. along with the Borosil vessel filled with water.

For control specimens were kept in water for 10 Hrs. before testing for strength. Analogue Pendulum is used for testing impact strength.

The Impact strength of tooth colored and repair resin after microwave and Chemical sterilization did not effect significantly. Table (1-4)

both the sterilization methods can be safely opted in everyday practice, the microwave method seems to be excellent alternative having the advantage of less time taking.

CONCLUSION

The following conclusions may be made under the conditions of this study.

1. Impact strengths of two groups (Tooth Colored and Repair Resin) did not change significantly when compared with control group of sterilization.
2. By Microwave sterilization there was no significant change in Impact strength of both resins.
3. It is concluded that microwave sterilization can be a better method compared to chemical sterilization.

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