

Original Research Article

## Effect of Two Chemical Disinfectants and Time of Immersion on the Transverse Strength of Three Heat Polymerizing Acrylic Resins Subjected to Short Curing Cycle- An in Vitro Study

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**Abstract:** Immersion in chemical solutions used for cleansing and disinfecting prostheses can decrease the strength of denture base resins, making them more prone to fracture during use. The aim of the present study was to assess the effect of two chemical disinfectants and time of immersion on the transverse strength of 3 heat-polymerized acrylic resins. A total of 120 rectangular specimens (65 x 10 x 3 mm), 40 per resin (Meliodent, Trevalon HI, DPI.), were fabricated using short curing polymerization cycle. One side of each specimen was not polished and the other was mechanically polished, and immersed for 15 or 30 minutes in either 0.525% sodium hypochlorite or 2% glutaraldehyde. The control specimens were immersed only in distilled water. The transverse strength (N/mm<sup>2</sup>) was tested for failure in a universal testing machine, at a crosshead speed of 5 mm/min. Multiple comparison using tukey test identified significant differences (P<0.05) in transverse strength between the three resins tested. No significant differences were observed between resins submitted to both types of disinfectants for different immersion periods (15 and 30 minutes), or interaction. Trevalon HI resin presented the greatest transverse strength values followed by Meliodent and DPI. Transverse strength of each resin was not affected significantly after immersion in the disinfectants for the immersion periods tested (15 and 30 minutes).

**Keywords:** Acrylic Resin, Disinfectants, Transverse Strength, Sodium Hypochlorite, Glutaraldehyde

### INTRODUCTION

Dental professionals are exposed to wide variety of micro organisms in daily clinical and laboratory procedures. These micro organisms can cause infectious diseases such as common cold, Herpes, Hepatitis B, Pneumonia, Tuberculosis and acquired immunodeficiency syndrome (AIDS) [1]. The potential sources of transmission of micro organisms to the dental professionals include contaminated instruments, impressions, gypsum casts and likewise, prostheses in contact with oral tissues, saliva, and blood from patients mouth at the various stages of trial and insertion, may be contaminated by pathogenic organisms, which can be transmitted through direct contact or through aerosol raised during trimming, finishing and/or polishing procedures [2]. Dental auxiliary personnel adjusting or repairing these prostheses may therefore be at risk of contacting infections from prostheses that have not been properly disinfected [3, 4].

Various precautions have been suggested to control cross infection that range from autoclaving, replacing pumice and wheel after each use, or adding disinfecting agents to the pumice [5]. A new denture should be fully disinfected or sterilized before delivery to the patient. Storage of the denture in disinfectant solution may reduce the possibility of bacterial, viral, and fungal colonization on the surface of the denture base.

The commonly used disinfectant solutions for immersion of dental prostheses include sodium hypochlorite, glutaraldehyde and chlorine dioxide [6-8]. Council on Prosthetic Services and Dental Laboratory Relations has recommended 1:10 to 1:100 dilution of 5.25% sodium hypochlorite for effective disinfection of denture base [9]. The available methods of disinfection have been shown to adversely affect some material properties like roughness, hardness, dimensional stability, color and transverse strength properties which may have an influence on the clinical outcome [10].

It is a recognized fact that denture base acrylic resins are subjected to different types of stresses. The flexural or transverse strength plays a critical role in resisting the intraoral stresses which are both compressive and tensile in nature [9]. The overall longevity of a dental prosthesis depends on the physical properties of the denture base resin, and that the denture base polymers may fail clinically due to flexural fatigue, the assessment of transverse strength is a reliable method to estimate the resin behavior under different experimental conditions.

Therefore the present study was planned to evaluate the effect of type of disinfectants on time of immersion and its co-relation to the transverse strength of denture base resins subjected to short curing polymerization cycles.

**MATERIAL AND METHODS**

This in vitro study was carried out to evaluate the effect of two brands of chemical disinfectants on the transverse strength of three brands of heat polymerized acrylic resins. The resins analyzed consisted of 3 brands of acrylic resin used in India (Meliodent, Trevalon and DPI).

**Specimen preparation**

A precise brass die was designed and fabricated using milling machine for obtaining wax blocks of uniform dimensions (Fig.1). Five rectangular slots measuring 65mm length, 20mm width and of 3mm in thickness were made in the die.

Wax specimens of the dimension 65mm×20mm×3mm were fabricated by pouring the molten wax in the brass die (Fig.2). After obtaining the wax specimens they were invested in the dental stone using water powder ratio of 0.28-0.30 i.e 28- 30ml of water in 100gms of powder using varsity flasks. The invested specimens were kept in boiling water for the elimination of wax for 4 minutes.

The mould was allowed to cool at room temperature and then separating medium was applied evenly using a paint brush. The heat polymerized resins were proportioned and mixed strictly following manufacturer’s instructions in a porcelain jar and they were packed in the mould in the dough stage of the resin.

Similar steps were carried out for the three brands of denture base resins used in the study. The packed resin in the varsity flask was pressed under hydraulic press at 2500psi pressure for samples of all the groups. The excess flash was removed and the final closure of the flasks is done using clamps.

The flasks were then placed in water curing bath at room temperature using a digitally controlled pre-programmed acrylizer.(Fig. 3)

A digital acrylizer was programmed specially for the purpose of carrying out this study. The acrylizer worked at 220 V input with a wattage of 2000 W. The cuing cycle was programmed at 73<sup>0</sup>C for 90 minutes followed by 100<sup>0</sup>C for 30 minutes.

The acrylic specimens were retrieved and finishing and polishing was carried out using laboratory micro motor, fine grit abrasive paper and pumice and the samples for all the three acylic resins were prepared. (Fig 4) By following the above technique, in all 120 test samples were fabricated, 40 for each brand of resin. The samples were divided under experimental and control groups. The experimental group samples (n=96), 32 for each resin were treated with 0.525% sodium hypochlorite and 2% Glutaraldehyde solution for times periods of 15 and 30 minutes. The control group specimen (n=24), 8 for each resin were immersed only in distilled water at the room temperature. All the samples were stored in distilled water for a period of 7 days at room temperature before disinfection and transverse strength testing. (Fig 5).

**Table-1: Distribution of the samples**

Group	Control Group		Experimental Group			
	Distilled water		0.525% Na Hypochlorite		2% Gluteraldehyde	
			15min	30min	15min	30min
Meliodent	8		8	8	8	8
Tevalon	8		8	8	8	8
DPI	8		8	8	8	8

**Transverse strength testing**

The samples were then subjected to the compression testing machine to measure the transverse strength using three point bending test (Fig 6). A fixture was used to hold the specimen for this purpose. The specimen were placed on the fixture with 30mm of length between the rollers for proper positioning, so that the specimens were equally distributed on both sides

and maintain contact on both sides of tyfixture. A “t” shaped stress applicator rod was placed with the upper member of the machine to exert load at the centre of the specimen. Thus, a three point contact for bending test is established. The upper member of the fixture moves down at a cross head speed of 5mm/min and applies uniform stress to the specimen. The readings were recorded and transverse strength was calculated. The

procedure was repeated for the entire specimen used in the study.

Transverse strength was calculated using the formula:

$$TS = 3pl / 2bd^2$$

Where

**TS**- Transverse strength (N/mm<sup>2</sup>)

**p**- Load at fracture (N)

**l** – Length of sample between two horizontal points (mm)

**b** – Width of the sample (mm)

**d** – Thickness of the sample (mm)

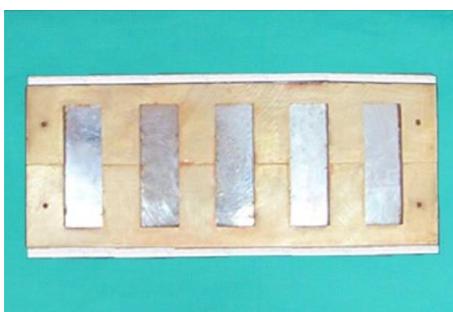
The values thus obtained were subjected for statistical analysis. Preliminary statistical analysis showed that the sample distribution was normal and homogeneous, thereby allowing the use of parametric tests. To compare the mean transverse strengths recorded for the tested resins with both types of disinfectants 1-way analysis of variance was performed. To identify differences among the means, Tukey statistical test was used. In order to clearly present the results and the significant differences, transverse strength data were gathered in 4 main groups, corresponding to each type of resin with disinfection treatment for varying time of immersion (15 and 30 minutes).



**Fig-3: Digitally controlled pre-programmed acrylizer**



**Fig-4: Acrylic Resin Specimens**



**Fig-1: Brass Die prepared using milling machine**



**Fig-5: Stored Specimen in distilled water**



**Fig-2: Wax Specimen prepared using brass die**



**Fig-6: Universal testing machine for three point bending test**

## RESULTS

The mean value and standard deviation of transverse strength for all three groups at different time

interval is as shown in Table 2, the one way ANOVA and multiple comparison identified no significant differences in the mean transverse strengths within each resin group immersed in 0.525% Sodium hypochlorite and 2% Gluteraldehyde with 15 and 30 minutes of immersion (Table 2).

The one way ANOVA and multiple comparisons identified significant differences in the mean transverse strengths between three resin groups Post Hoc multiple comparisons by Tukey test showed significant differences among the means recorded for the 3 resin materials, with Trevalon HI yielding the highest overall transverse strength (Table 3).

**Table-2: Transverse strength of three different acrylic resins (Mean ± SD) and Comparison within the group**

Heat-Polymerized acrylic resins	Control (Distilled water)	0.525% Sodium Hypochlorite		2% Gluteraldehyde		p- value
		15 minutes	30 minutes	15 minutes	30 minutes	
Meliodent	88.13±2.31	87.93±2.31	87.68±2.31	87.5±2.31	87.8±2.31	0.822 NS
Trevalon	105.78±5.61	105.58±5.61	105.15±5.61	105.33±5.61	106.45±5.61	0.992 NS
DPI	97.77±3.31	97.57±3.31	97.14±3.31	97.32±3.31	98.44±3.31	0.945 NS

**Table-3: Comparison between the group the Transverse strength of three different acrylic resins**

	15 Min (p-value)	30 Min (p-value)
0.525% Sodium Hypochlorite	Meliodent Vs Trevalon (<0.001*) Meliodent Vs DPI (<0.001 *) Trevalon Vs DPI (<0.001 *)	Meliodent Vs Trevalon (<0.001*) Meliodent Vs DPI (<0.001 *) Trevalon Vs DPI (<0.001 *)
2% Gluteraldehyde	Meliodent Vs Trevalon (<0.001*) Meliodent Vs DPI (<0.001 *) Trevalon Vs DPI (<0.001 *)	Meliodent Vs Trevalon (<0.001*) Meliodent Vs DPI (<0.001 *) Trevalon Vs DPI (<0.001 *)

\* p value < 0.05 considered significant

**DISCUSSION**

The ultimate goal of dentistry is to maintain and improve the quality of life of the dental patient. Edentulousness is not a disease entity by itself, but rather a consequence of pathology. The treatment of the individuals with artificial dentures not only rehabilitates them functionally, but also esthetically, psychologically and socially. Yet the mainstay for the management of a complete or partially edentulous state, till date remains to be an acrylic denture. The main challenges for centuries have been the development and selection of biocompatible, long lasting and indirectly processed prosthetic materials that can withstand the adverse conditions of oral environment. Over a period of their use denture base materials can be colonized and deeply infected by microorganisms. Contaminated prostheses can provide a source of cross-contamination between patients and dental personnel. This contaminated prosthesis can spread microorganisms to other materials, equipment, and personnel through contact or air borne during adjustments. The inadvertent spread of infection or disease through the dental laboratory could occur at the lathe and that the contaminating organisms were primarily oral flora from previously polished dentures and used laboratory pumice [3].

In a study conducted by Michael L. Brace and Kevin D. Plummer on denture disinfection, dental laboratory technicians tested positive for serological markers for hepatitis B [17]. Evidence of direct transmission of disease from the dental laboratory is

limited. It has been documented by Charles W. Henderson et al that dentures from diseased patients were identified as the source of an outbreak of *M Pneumoniae* infections in personnel of a dental laboratory [11].

To avoid or reduce microbial contamination in the laboratory and to prevent cross contamination various methods have been suggested like lathe hoods and strong suction to reduce splatter and aerosol while polishing, disinfectant solution as a wetting agent for pumice, unit doses of pumice, clean pumice pans, autoclaving of pumice, sterile muslin wheels. Autoclaving and replacing the pumice and rag wheels are costly, and adding disinfectants to the pumice is not effective solution to prevent cross-contamination. Therefore, immersion in disinfectants is recommended for denture disinfection before handling it to patient for use [7, 11].

Chemical disinfectants that are accepted and recommended by the Council on Dental Therapeutics include Chlorine solution such as household bleach, which is 5.25 % sodium hypochlorite solution which is 1:10 to 1:100 dilutions as a surface disinfectant for in-service prostheses. Glutaraldehyde in 2% solution can disinfect within 10 minutes. Various concentrations of sodium hypochlorite viz. 5.25%, 1:10 dilution of 5.25% for varying immersion times of 4 minutes, 5minutes, 10 minutes and 30 minutes have been proved as effective immersion disinfectant for denture disinfection. Fresh

solution of chlorine dioxide and sodium hypochlorite (1:10 dilution of 5.25%) was effective against *Staphylococcus aureus*, *Candida albicans*, or *Escherichia coli* on acrylic resin strips when organic matter was present [12].

Rudd *et al.* demonstrated that 5.25% sodium hypochlorite solution could be a rapid, safe and clinically effective way to sterilize complete dentures. However, the soaking of dentures in 5.25% sodium hypochlorite was discouraged because of its possible bleaching effect on the denture material [13]. The objective of immersing a denture base in a disinfectant solution is to inactivate infectious viruses and bacteria. It has been emphasized that some disinfectants may adversely affect the physical properties of denture base resin like hardness, dimensional stability, color and flexural properties, and may have an influence on clinical outcome.

Among all causes of denture failure, fracture has been found to be one of the most common factors. During mastication, a load applied through the teeth of a denture forces the base against the hard tissue of the mouth. The compressibility of the soft tissue lying between the bone and denture are such that dentures may bend in midline. Stress analyses have indicated that compressive stresses occur in maxillary base adjacent to supporting tissues, with tensile stresses elsewhere. Flexural or transverse strength is thus one of the important and desirable properties of denture base material to have optimum function of prosthesis [14].

The present study was conducted to evaluate the effect of two disinfectant solutions and varying immersion periods on the transverse strength of the three brands of heat polymerized acrylic resins. A comparison of the transverse strength between three popular brands of heat polymerizing resins was also carried out.

The results of this study demonstrated that there was significant difference among the three resins submitted to two disinfectant solutions for varying immersion periods with respect to the transverse strength. Trevalon HI yielded the highest overall transverse strength compared to the Melident and DPI. The differences in the composition, polymer chain formation primarily due to plasticizers may explain the difference in the transverse strength of the different materials.

Considering the type of disinfectant solution (0.525% Na Hypochlorite and 2% Gluteraldehyde), no significant differences were observed among the mean transverse strengths recorded. These outcomes were in agreement with the study conducted by Iara Augusta Orsi, Vanessa Gom Andrade and Polyzois *et al.* which evaluated the effect of chemical disinfectants on transverse strength of heat polymerized acrylic resin

submitted to chemical and mechanical polishing [15, 16].

Considering the immersion periods tested (15 and 30 minutes) for the two disinfectants, no significant differences were observed among the mean transverse strengths recorded. These outcomes are in agreement with the Shen *et al.* who reported that period of immersion up to 12 hours did not affect the transverse strength of the specimens [7].

The result of this study reveal that disinfection of the dentures if carried out with 2% Gluteraldehyde or 0.525% sodium hypochlorite for immersion periods of 15 minutes and 30 minutes does not compromise the transverse strength of the heat polymerized resin. Hence, it can be recommended routinely in practice to provide more acceptable prosthesis.

## CONCLUSION

Based on the results from this study, the following conclusions were drawn:

- Trevalon HI resin demonstrated the highest overall transverse strength for the materials tested. It was significantly stronger than Meliodent and DPI. ( $P < 0.05$ ).
- The 3 acrylic resins did not demonstrate significant changes in transverse strength during immersion in the disinfecting solutions tested, regardless of time of immersion.
- Both the disinfectants can be used for disinfecting dentures as no significant effect was noticed on transverse strength of the denture base resins. However, effects on the other physical properties of the denture base resins need to be verified by further research transverse strength following immersion in the disinfectants when compared to the control specimens.

## REFERENCES

1. Asad T, Watkinson AC, Huggett R; The effects of various disinfectant solutions on the surface hardness of an acrylic resin denture base material. *Int J Prosthodont*, 1993; 6:9-12.
2. Vig RG; Reducing laboratory aerosol contamination. *J Prosthet Dent*, 1969; 22: 156-7.
3. Katberg JW; Cross-contamination via the prosthodontic laboratory. *J Prosthet Dent*, 1974; 32: 412-9.
4. Powell GL, Runnelis RD, Saxon BA, Whisenant BK; The presence and identification of organisms transmitted to dental laboratories. *J Prosthet Dent*, 1990; 64: 235-7.
5. Wakefield CW; Laboratory contamination of dental prostheses. *J Prosthet Dent*, 1980; 44: 143-6.

6. Larato DC; Disinfection of pumice. *J Prosthet Dent*, 1967; 18:534-5.
7. Shen C, Javid NS, Colaizzi FA; The effect of glutaraldehyde base disinfectants on denture base resins *J.Prosthet Dent*, 1989; 61: 583-589
8. Campanha NH, Pavarina AC, Vergani CE, Machado AL; Effect of microwave sterilization and water storage on the Vickers hardness of acrylic resin denture teeth. *J Prosthet Dent*, 2005; 93:483-7.
9. Council on Dental Therapeutics, Council on Prosthetic Services and Dental Laboratory Relations. Guidelines for infection control in the dental office and the commercial laboratory. *J Am Dent Assoc*, 1985; 110:969-72.
10. Schiff ER, de Medina MD, Kline SN; Veterans Administration cooperative study on hepatitis and dentistry. *J Am Dent Assoc*, 1986:113:390-6.
11. Henderson CW, Schwartz RS, Herbold ET, Mayhew RB; Evaluation of the barrier system, an infection control system for the dental laboratory. *J Prosthet Dent*, 1987; 58:517–21.
12. Bell JA, Brockmann SL, Fell P, Sackwick DA; The effectiveness of two disinfectants on denture base acrylic resin with an organized load. *J Prosthet Dent*, 1989; 61: 580-3.
13. Rudd RW, Senia ES, McCleskey FK, Adam ED Jr.; Sterilization of complete dentures with sodium hypochlorite. *J Prosthet Dent*, 1984; 51:318- 21.
14. Arundhati R, Patil NP; An investigation into the transverse strength of new indigenous high-impact denture base resin, DPI- and its comparison with most commonly used two denture base resins. *J Ind Prosth Soc*, 2006; 6:133-8.
15. Orsi IA, Andrade VG; Effect of chemical disinfectants on the transverse strength of heat-polymerized acrylic resins submitted to mechanical and chemical polishing. *J Prosthet Dent*, 2004; 92:382-8
16. Polyzois GL, Zissis AJ, Yannikakis SA; The effect of glutaraldehyde and microwave disinfection on some properties of acrylic denture resin. *Int J Prosthodont*, 1995; 8:150.
17. Brace ML1, Plummer KD. Practical denture disinfection. *J Prosthet Dent*. 1993;70(6):538-40