

Microhardness of heat cure acrylic resin after treatment with disinfectants

Faiza Amin,¹ Abdur Rehman,² Muhammad Abbas³

Abstract

Objective: To evaluate the effect of disinfectants and distilled water on the micro-hardness of heat cure acrylic resins.

Methods: The case-control study was conducted at Dr. Ishrat-ul-Ebad Khan Institute of Oral Health Sciences, Dow University of Health Sciences, and Nadirshaw Edulji Dinshaw University of Engineering and Technology, Karachi, from April to October 2011. Specimens were fabricated from heat cure acrylic resin material and they were divided into four equal groups. Group 1 was evaluated at baseline and was taken as the control group. Group 2 was immersed in distilled water for 20 minutes, Group 3 in 1% sodium hypochlorite for 20 minutes, and Group 4 in 2% alkaline gluteraldehyde for 10 minutes. All specimens were polished, stored in distilled water for 24 hours prior to experiment. All the specimens were immersed twice daily for a total of 60 days after which they were tested for Vickers micro-hardness test. Statistical analysis was conducted with one-way analysis of variance and Tukey post hoc test ($\alpha=0.05$).

Results: There were 72 specimens divided into four groups of 18(25%) each. Statistically significant differences were found among all groups ($p<0.0001$). The storage medium had an effect on the micro-hardness of heat cure acrylic resins. Group 4 showed the most reduction in the hardness value which was followed by Group 3.

Conclusions: The hardness of heat cure acrylic resin was affected by disinfectants.

Keywords: Heat cure acrylic resins, Vickers micro-hardness, Disinfectants. (JPMA 65: 834; 2015)

Introduction

Polymethyl methacrylate is one of the most widely used materials in prosthetic dentistry. Since 1937 this material has been used for denture base manufacturing^{1,2} because of its low water sorption and solubility, lack of toxicity, simple manipulation technique, excellent aesthetics and reparability. Compression moulding technique is one of the conventional methods for curing resins.³⁻⁵ The technique is advantageous because of the lack of a need for any expensive or sophisticated equipment, its familiarity for technicians and dentists, and ease of processing. However, this technique has few disadvantages like it may give rise to inaccuracies in the fitting of the denture base and dimensional changes which result in high- processing stresses during polymerisation induced in the resin.⁶⁻⁸

It has been claimed that there is a statistically significant correlation between denture stomatitis and insufficient cleanliness of the dentures. To maintain the oral health of denture-wearers, the removal of biofilm is clinically necessary. This can be accomplished by decontaminating the prosthesis properly.⁹ A study indicated that to

minimise the adherence and colonisation of micro-organisms on the denture base, denture polishing is essential.¹⁰ However, one study¹¹ found that after denture polishing micro-organisms can be easily transmitted to patients.

Literature has shown that for reducing micro-organisms, a 0.5% sodium hypochlorite solution can be used as an effective denture cleanser¹² to prevent oral candidiasis.¹³ Equally, it has been suggested that on maxillary dentures the number of *Candida albicans* (*C. albicans*) colony-forming units and bacterial plaque can be reduced by using alkaline peroxide tablets.^{14,15} Therefore, it is very important to choose the appropriate methods for cleaning of the denture to prevent microbial adhesion when the objective of the procedures is not to cause damage to the denture base.

The denture base hardness is used to evaluate the changes in the surface characteristics of acrylic resins and that result from denture cleansers,¹⁶ thermal cycling¹⁷ toothbrush/dentifrice abrasion¹⁸ and different systems of denture base polymerisation.¹⁹ Literature showed that different acrylic resins present significantly lower hardness after being submitted to 3.78% sodium perborate solutions of 1% sodium hypochlorite and 4% chlorhexidine gluconate solutions.²⁰ Previous studies have shown that the hardness of a denture base is not significantly decreased by decontaminating in 4%

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¹Dow Dental College. Dow University of Health Sciences, ²Hamdard University Dental Hospital, Hamdard University Karachi, ³Ministry of Health Kingdom of Saudi Arabia.

Correspondence: Abdur Rehman. Email: abdurrehmanmds@gmail.com

chlorhexidine solutions or 1% sodium hypochlorite for 1 minute²¹ and in sodium perborate for 10 minutes.²² Conversely, the hardness of acrylic resins is reported to be changed by solutions of 4% chlorhexidine, 2% glutaraldehyde or 1% sodium hypochlorite.²³ It is possible that due to cleaning and disinfecting treatments, surface hardness of acrylic resins can be decreased which will result in micro-organism adherence and formation of biofilm on the dentures.

Based on these considerations we planned the current study to assess the effect of the chemical disinfection on the surface hardness of acrylic resins.

Materials and Methods

The in vitro case-control study was conducted at Dr. Ishrat-ul-Ebad Khan Institute of Oral Health Sciences, Dow University of Health Sciences, and Nadirshaw Edulji Dinshaw (NED) University of Engineering and Technology, Karachi, from April to October 2011. Conventional (Vertex™ Rapid Simplified Holland) (Table-1) heat-polymerised acrylic resins were used to manufacture rectangular samples 13.0mm in length and 4.0mm in thickness. These dimensions were according to the American Society for Testing and Material standard D 256-O6a.^{24,25}

A vertex rapid simplified resin with ratio of 1ml of liquid (monomer) and 2.3gm of powder (polymer) was manipulated according to manufacturer's recommendation. When it reached the dough stage, the resulting mass was inserted in stainless steel mould (Figure-1) and polymerised at 100°C for 20 minutes according to manufacturer's instructions, using curing tank. After curing the mould, it was bench-cooled at room temperature for 30 minutes. Specimens were then taken out from mould and the excess margins were trimmed with tungsten carbide bur. Subsequently, the specimens were submitted to finishing and polishing with 320-, 400- and 600-silicon carbide paper. Finishing and polishing procedures were carried out for 8 seconds under a load of 20g. The specimens were then stored in water at room temperature for 24 hours.

They were divided into four equal groups. Group 1 was

Table-2: Mean of micro-hardness at baseline (0 day) and 60 days of immersion in various groups.

Groups	Mean and Standard Deviation
Baseline (0 day) (Control)	19.95±0.20c
Distilled water	19.77±0.30c
1% Sodium Hypochlorite	12.311±0.18b
2% Alkaline Gluteraldehyde	10.08±0.07a

Means with the same letters were not significantly different at p= 0.05.

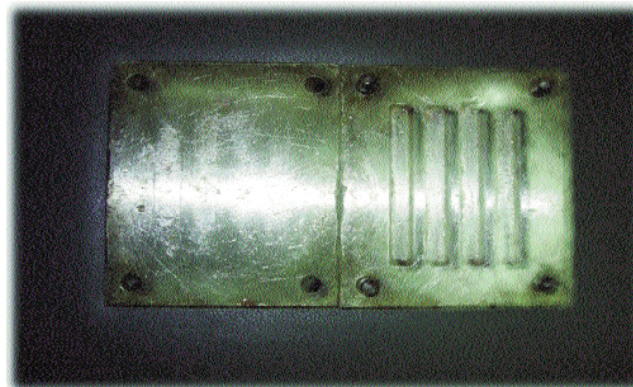


Figure-1: Stainless steel mould for specimen fabrication.

evaluated at baseline and was taken as the control group. Group 2 was immersed in distilled water for 20 minutes, Group 3 in 1% sodium hypochlorite for 20 minutes, and Group 4 in 2% alkaline gluteraldehyde for 10 minutes. This was done according to American Dental Association (ADA) specifications.

The specimens in the control group were measured at day 0. All the other specimens were placed in their respective containers filled with distilled water. After 24 hours the distilled water was discarded and the container was filled with their respective denture cleansers. The specimens were washed with distilled water and stored in distilled water. This was repeated twice a day for 60 days after which micro-hardness test was carried out by Vickers micro-hardness tester (Wolpert W Group micro Vickers hardness tester digital auto-turret model number

Table-1: Material used.

Material	Type	Processing method	Manufacturer
Heat cure acrylic resins	PMMA	Heat cure polymerization 100°C for 20 min in the curing tank	Vertex™ Rapid Simplified
Disinfectants	Hospital Based Disinfectants	1% Sodium Hypochlorite for 20 minutes 2% Alkaline Gluteraldehyde for 10 minutes	Universal Traders Chemical Supplies Pakistan.

PMMA: Poly Methyl Methacrylate.

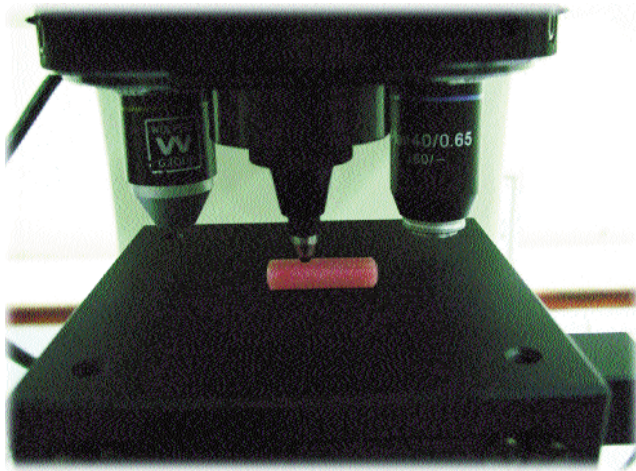


Figure-2: Specimen in Vickers hardness machine.

402MVD) (Figure-2). Specimens were placed in distilled water during storage.

Data analysis was performed using SPSS16. One-way analysis of variance (ANOVA) was used for a quantitative dependent variable by a single factor (independent) variable. To identify which of the mean differed significantly, Tuckey's Honestly significant difference (HSD) was used at 0.05 significance level.

Results

There were 72 specimens divided into four groups of 18(25%) each. Statistically significant differences were found among all groups ($p < 0.0001$). The storage medium had an effect on the micro-hardness of heat cure acrylic resins. Group 4 showed the most reduction in the hardness value which was followed by Group 3 (Table-2).

Post Hoc analysis showed that when specimens were immersed in distilled water for 60 days and compared with the specimens at 0 day, the difference was not statistically significant ($p = 0.067$). In Group 3, the difference was significant ($p < 0.0001$), and the same was the case with Group 4 ($p < 0.0001$).

Discussion

The study evaluated the hardness of denture base acrylic resin after an infection control protocol. The hypothesis that both disinfectants could not cause any adverse effects on the hardness of the denture base was rejected. The study investigated the effect of disinfectant solutions on the hardness of denture base resins after long-term storage in disinfectants and distilled water. The results demonstrated that specimens that were stored in 1% of sodium hypochlorite exhibited statistically significant

differences in the surface hardness when compared with the specimens that were stored in the distilled water. No significant differences were found between the specimens at baseline (control) (0 day) and at 60 days of storage in distilled water. The results oppose those of a study²⁶ in which disinfection with hypochlorite solution did not influence the hardness of the denture base material. The results, however, are similar to a study²⁷ which evaluated the hardness of denture teeth by immersing them into the disinfectant solution. In both the studies, surface hardness was higher at baseline (0 day) and decreased after immersion in water and solution. This might have been possible because of the presence of cross-linking agents in the materials. According to a study,²⁸ the denture base resins acquire two valuable properties because of cross-linking agent. Solubility of the denture base to organic solvents is reduced. During stress, these cross-linking agents prevent the denture from crazing. In the present study, vertex rapid simplified heat cure acrylic resin was used and it also contained cross-linking agent so it can be assumed that because of the cross-linking of the acrylic resin, the surface hardness remained unaffected after immersing into the disinfectant solutions in both the studies. The reason of similar results in both the studies might be due to the fact that the specimens were placed in water throughout the study period. This caused leaching of residual methyl methacrylate (MMA) content from the resins resulting in increased or unaffected hardness of the material.²⁸

In the present study, when the specimens were treated with 1% sodium hypochlorite and 2% alkaline glutaraldehyde, there was significant decrease in the micro-hardness of the material when compared with the baseline and distilled water. However, contrasting results were obtained in a study^{27,28} which reported increased hardness after 7 days of immersion in 1% sodium hypochlorite and 4% chlorhexidine gluconate for 10 minutes. There might be slow leaching of residual monomer into the storage solutions, causing an increase in the hardness of acrylic resins. It should be emphasised that the increase in hardness values which were obtained in the present study were not significant and the increase was extremely small (less than 1 Vickers hardness number [VHN]) and not of any practical importance. In our study, the hardness values were higher at baseline compared to the hardness values after 60 days of immersion.²¹

Our results are similar to those of a study²⁰ which showed that after immersion in 1% sodium hypochlorite, there was significant decrease in hardness value of heat cure acrylic resin. The slight difference in the results may be due to the fact that the studies used different brands of

material which possesses different curing cycle and properties.

Immersion in disinfectants solution used in this study did not turn out to be a safe disinfection process for surface hardness of dentures. However, our study has limitations and it is not possible to extrapolate these results to other types of denture base resins having different compositions or different processing techniques. The effect of disinfectants and cleansers on other physical and chemical properties after long immersion period is also unknown in this study.

Conclusion

Immersion in sodium hypochlorite and alkaline glutaraldehyde produced significant changes on surface hardness of heat cure acrylic resins, while immersion in distilled water did not produce significant changes.

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