EFFECT OF FOUR DIFFERENT DISINFECTANT SOLUTIONS ON THE SURFACE ROUGHNESS OF HEAT CURE ACRYLIC RESIN AT DIFFERENT TIME INTERVALS- AN IN VITRO STUDY

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Abstract

Background-Heat-cured PMMA are used for fabrication of dentures. Surface roughness of denture is an importantfactor determining plaque deposition. We aimed to determine the effect on the surface roughness of heat cure acrylic resin after immersion in four different disinfectant solutions viz. 2% chlorhexidine, 2% glutaraldehyde,2% sodium hypochlorite, and a novel disinfectant solution.

Material & methods- Forty-eight specimens made of heat-cure denture acrylic resin were equally divided into 4 groups: Group 1- 2% chlorhexidine disinfectant solution; Group 2- 2% glutaraldehyde disinfectant solution; Group 3- 2% sodium hypochlorite disinfectant solution; Group 4- a novel disinfectant solution (a combination of hypochlorous acid (0.05%) and electrolyzed oxygenated water (99.95%) disinfectant solution). In each group, specimens were further subdivided into 2 subgroups. In subgroup A and B, the specimens were immersed for 10 minutes and 6 hours respectively. Specimens were examined under stereo-microscope™.

Results- After immersion in the respective solution, no significant change in surface roughness was seen in group 1A, 1B, 2A and 2B (p-value>.05) whereas a significant increase in surface roughness was observed in group 3A, 3B, 4A and 4B (p-value <.05). Immersion for longer period caused significant increase in surface roughness only in group 4.

Conclusion-10-minutes and 6-hours of exposure to 2% chlorhexidine and 2% glutaraldehyde do not cause a significant change in the surface roughness of heat cure acrylic resin whereas 10-minutes and 6-hours of exposure to 2% sodium hypochlorite and novel solution cause a significant change in the surface roughness of heat cure acrylic resin.

Keywords- Acrylic resin; Surface roughness; Denture base material; Sodium Hypochlorite; Chlorhexidine

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INTRODUCTION

Dentures are custom-made devices used for the replacement of oral hard and soft tissues. The most common material used for the fabrication of dentures is heat-cured polymethyl methacrylate resin (PMMA). Heat-cured PMMA is non-shedding and inherently porous, thus, aggregates plaque readily.[1] Denture plaque includespathogenic microorganisms such as Candida *albicans*, Streptococcus *mutants*, and Staphylococcus *aureas* which are linked with denture stomatitis, dental caries and infective endocarditis respectively. The pathogenicity of the microorganisms present in denture plaque necessitates the prevention of plaque accumulationon the denture.[1]

Various pastes, abrasives, and solutions are used for the maintenance of denture cleanliness.[2] Abrasive denture cleaners increase the surface roughness of dentures which is an important factor determining plaque accumulation.[3] Sodium hypochlorite, Chlorhexidine, glutaraldehyde, and alkaline peroxide are known for their antibacterial activity and therefore, they are among some of the commonly used solutions for the prevention of biofilm formation on dentures.[2] Electrolyzed oxidizing water (EOW) is a promising novel antimicrobial agent. Recently, it has been proposed as an alternative to conventional decontamination methods such as heat and chemical sanitizers.[4] Few adverse effects on acrylic denture base resins have been reported with the use of these solutions.[5] However, it is believed that immersion of dentures in disinfectant solution causes less changes in the surface roughness.[3] These solutions Although the evidence supporting the above fact is insufficient and therefore this study was undertaken with the aim to determine the effect on the surface roughness of heat cure acrylic resin after immersion in four different disinfectant solutions viz. 2% chlorhexidine, 2% glutaraldehyde, 2% sodium hypochlorite, and a novel disinfectant solution [combination of hypochlorous acid (0.05%) and electrolyzed oxygenated water (99.95%)].

MATERIAL & METHODS

Experimental design

The study was conducted in the Department of Prosthodontics and Crown and Bridge, and Central Laboratory of Vinayaka Missions Sankrachariyar Dental College Salem, Tamil Nadu, India.

In this study, 48 specimens made of heat-cure denture base materials (DPI)™ and having uniform dimensions: 4 cm in length, 3 cm in width, and 2 mm in thickness were included. Specimens were equally allocated to 4 groups:

Group 1- 2% chlorhexidine disinfectant solution (Asep- RC) ™,

Group 2- 2% glutaraldehyde disinfectant solution (CIDEX)™,

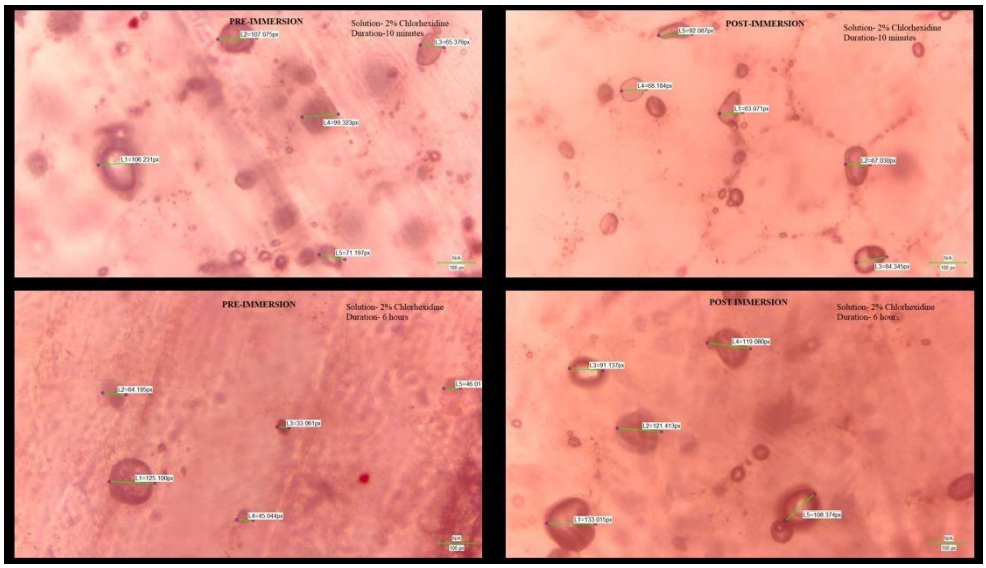
Group 3- 2% sodium hypochlorite disinfectant solution (VIP)™.

Group 4- a novel disinfectant solution, a combination of hypochlorous acid (0.05%) and electrolyzed oxygenated water (99.95%) disinfectant solution.

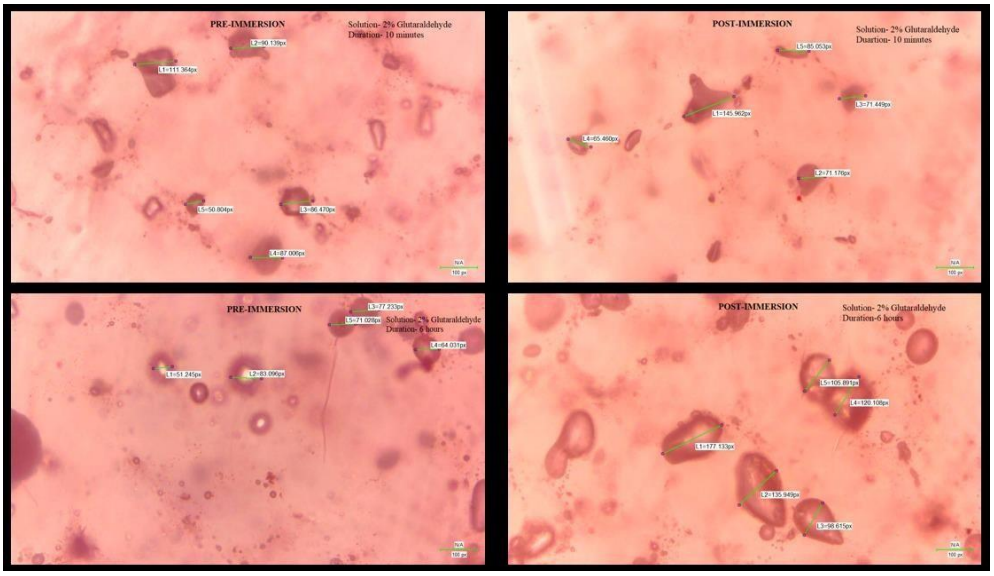
In each group, specimens were further subdivided into 2 subgroups based on the duration of immersion of the specimen in the solutions. In subgroup A and subgroup B, the specimens were immersed for 10 minutes and 6 hours respectively. Before and after immersion of the specimen for the desired period of time, the specimens were examined under stereo-microscope™ (WESWOX DPTIK, model STM- 80)® at 40x magnification, the images thus obtained were evaluated with image analyzer software (Scopelmage 9.0.) for surface roughness. For each specimen, the five largest sizes of porosities were measured, and the mean of the five values was calculated per sample. The final mean of six samples in each subgroup was calculated to obtain a single result.

Statistical analysis

Data were analyzed using SPSS (Statistical Package for Social Sciences) 21.0 version, IBM, Chicago. Data were analyzed for probability distribution using the Kolmogorov-Smirnov test, data were found to be normally distributed and thus parametric tests of significance were employed. P-value <.05 was considered statistically significant.



Picture 1



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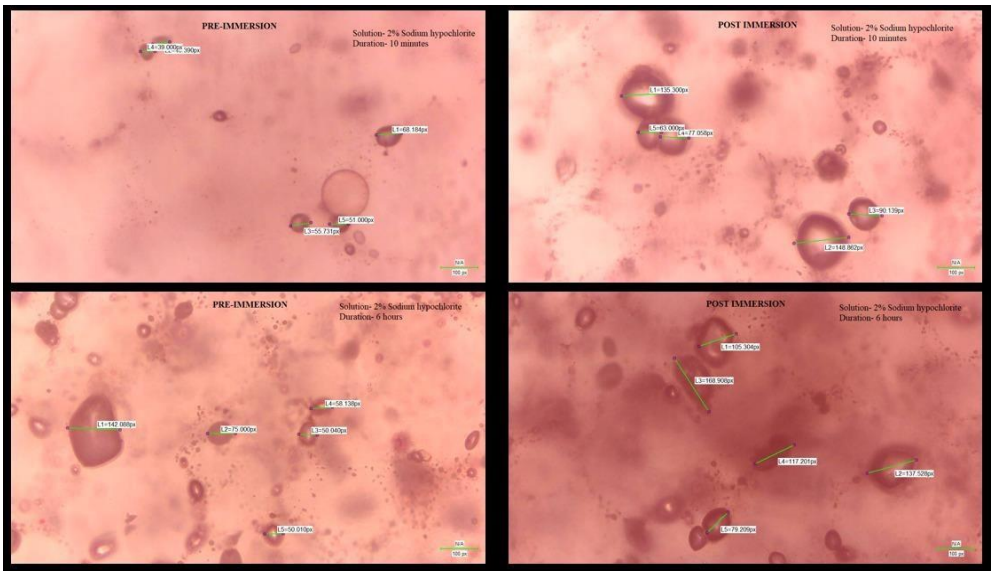

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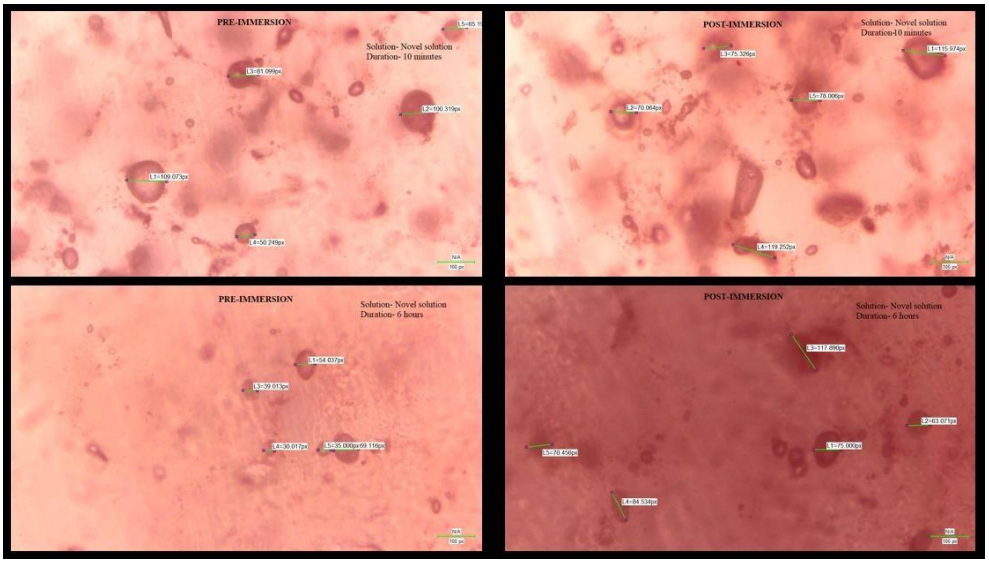

Picture 4

RESULTS

The results of the study showed that immersion of specimens in 2% chlorhexidine and 2% glutaraldehyde for 10 minutes or 6 hours caused no significant change in surface roughness (p-value >.05) whereas immersion of specimens in 2% sodium hypochlorite and novel disinfectantsolution resulted in a significant increase in surface roughness of the specimens (p-value <.05). [Table 1] [Figure 1] To know the effect of prolonged immersion on surface roughness, a comparison of surface roughness was done between two sub-groups of all the groups. Results showed that the surface roughness was non-significantly greater in groups 1B, 2B, and 3B compared to groups 1A, 2A, and 3A respectively. However, the surface roughness of specimens in group 4B was significantly more compared to group 4Aspecimens (p-value <.05). [Table 2] [Figure 1] Theimages of the stereo-microscopic examination have been presented in Pictures 1, 2,3, and 4.

Table 1. Comparison of surface roughness of samples of different groups before and after immersion into solution.

Groups		Mean ± standard deviation	T value	P-value[a]
Group 1A	Pre-immersion	1853.33 ± 341.886	-1.860	.122
	Post-immersion	2211.83 ± 336.288		
Group 1B	Pre-immersion	2745.50 ± 1971.724	.107	.919
	Post-immersion	2664.50 ± 469.193		
Group 2A	Pre-immersion	2152.17 ± 604.449	-.937	.392
	Post-immersion	2406.33 ± 523.159		
Group 2B	Pre-immersion	2039.83 ± 274.177	-1.754	.140
	Post-immersion	2455.33 ± 493.524		
Group 3A	Pre-immersion	2169.00 ± 196.681	-8.777	.001*
	Post-immersion	2681.83 ± 184.824		
Group 3B	Pre-immersion	1670.83 ± 290.432	-5.483	.003*
	Post-immersion	3103.00 ± 695.850		
Group 4A	Pre-immersion	1629.00 ± 146.364	-4.870	.005*
	Post-immersion	2544.67 ± 453.007		
Group 4B	Pre-immersion	2487.17 ± 647.892	-5.023	.004*
	Post-immersion	3156.00 ± 503.307		

[a]Paired t-test. *p-value <.05 was considered statistically significant.

Figure 1. Before and after immersion surface roughness of the samples belonging to different groups.

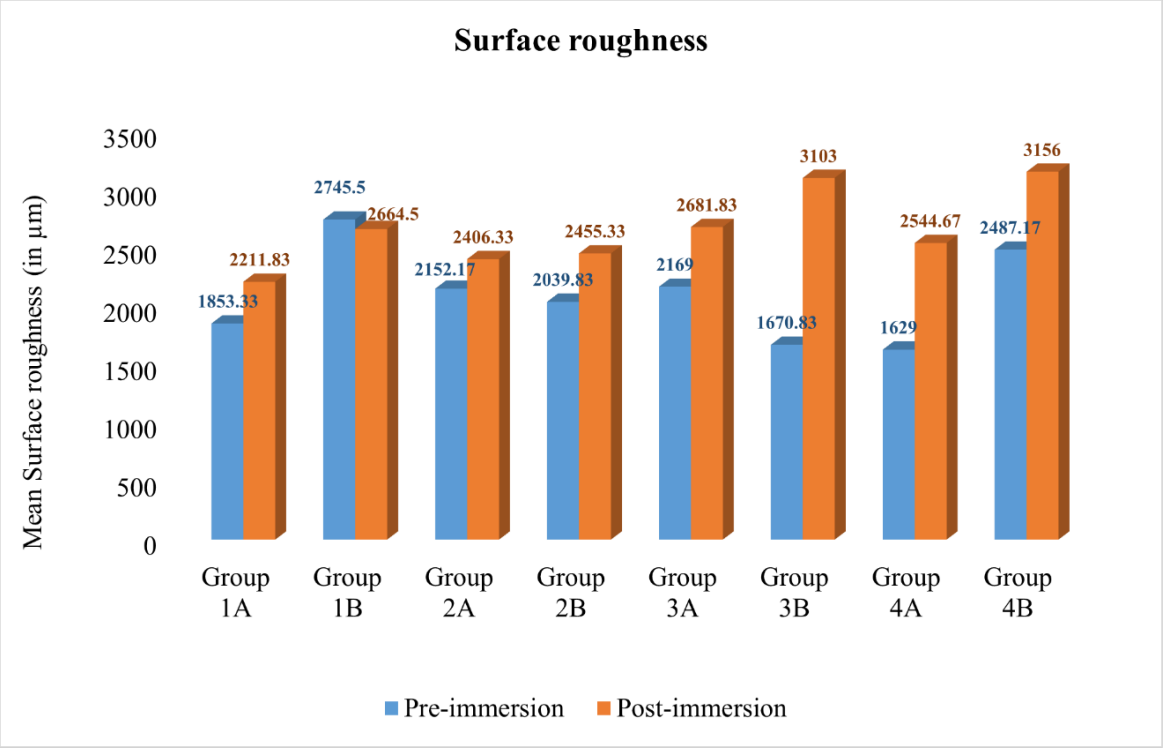

Table 2. Comparison of post-immersion surface roughness of samples of groups after immersion for 10 minutes and 6 hours.

Groups	Mean ± standard deviation	T value	P-value$^{\Omega}$
Group 1A	2211.83 ± 336.288	-1.698	.150
Group 1B	2664.50 ± 469.193		
Group 2A	2406.33 ± 523.159	-.224	.832
Group 2B	2455.33 ± 493.524		
Group 3A	2681.83 ± 184.824	-1.783	.135
Group 3B	3103.00 ± 695.850		
Group 4A	2544.67 ± 453.007	-3.414	.019*
Group 4B	3156.00 ± 503.307		

$^{\Omega}$Independent t-test. *p-value <.05 was considered statistically significant.

DISCUSSION

A rough surface on a denture creates niches that protect micro-organisms from dislodgement by mechanical force.[6] Biofilm on dentures has been linked to dental caries, candidiasis, malodor, infectious endocarditis, and chronic obstructive pulmonary disease.[6] Therefore, it is mandatory to clean the dentures with a suitable approach which includes both mechanical and chemical approaches. The chemical method includes immersion of denture in disinfectant solution.

It is recognized that biofilm formation and subsequent plaque deposition on the denture base are substantially affected by its surface roughness.[6] Therefore, in this study effect of 3 commonly used disinfectants and a novel disinfectant solution on the surface roughness of heat-cure acrylic denture resin has been studied. Evidence suggests that immersion of the dentures in disinfectants for 6-8 hours provides adequate disinfection.[7] Therefore, in this study roughness was evaluated at 6-hour interval, roughness was also assessed at 10 minutes interval to assess the immediate effect of the solution on roughness and also because few researchers have advocated the use of 1% hypochlorite and glutaraldehyde for 10 minutes for efficient disinfection.[8]

Our study showed that 2% chlorhexidine and 2% glutaraldehyde cause no significant damage to the roughness of the heat-cure acrylic resin material. However, 2% sodium hypochlorite and a combination of hypochlorous acid (0.05%) and electrolyzed oxygenated water (99.95%) significantly increase the roughness of the heat-cure acrylic resin. It was also found that greater the duration of exposure, greater the surface roughness. Similar to our findings, Ma T *et al*. (1997) found chlorhexidine and glutaraldehyde to exert insignificant effects on denture roughness.[9]

Schwindling FS *et al.* (2014) in their systematic review reported that chlorhexidine and glutaraldehyde are non-damaging to the dentures in terms of surface roughness.[10] Azevedo A *et al.* (2006) reported that 4% chlorhexidine did not affect the surface roughness of the two acrylicresins evaluated in their study. However, in the same study contrary to our findings, sodium hypochlorite was also not found to have any significant effect on surface roughness.[11] In a recentmeta-analysis, Costa RT *et al.* (2021) also reported different concentrations of NaOCl to cause fewer changes in the surface roughness of the denture base.[12]

Sharma P *et al*. (2017) exposure to sodium hypochlorite for 3 months influences the surface roughness of heat cure denture base resin.[13]

Polymerized acrylic resins contain residual methyl methacrylate monomer. These residues leach out under the effect of chlorine-containing solutions which brings change in mechanical properties.[14] This could be the reason for an increase in surface roughness on immersion in hypochlorite solution and novel solution as found in our study.

Presumptively, the difference in the findings of different studies was because of the difference in the material (difference in composition seen with variation in brands), the concentration of the solution, and the duration of immersion in the solution employed in various studies.

Limitations of the study

- The mean surface roughness of the samples at baseline was greater than the threshold roughness for plaque accumulation i.e., 0.2 µm.[15] Inclusion of specimens with surface roughness less than 0.2 µm could have better helped in understanding the role played by disinfectants in increasing surface roughness to or above the threshold leading to plaque accumulation.
- In this study control group has not been included.

CONCLUSION

With the given limitations of this study, it was concluded that 10 minutes and 6 hours of exposure to 2% chlorhexidine and 2% glutaraldehyde do not cause a significant change in the surface roughness of heat cure acrylic resin whereas 10 minutes and 6 hours of exposure to 2% sodium hypochlorite and novel solution cause a significant change in the surface roughness of heat cure acrylic resin. An exposure of 6 hours to the novel solution causes significantly greater surface roughness of heat-cure acrylic resin compared to exposure for 10 minutes.

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