

# ORIGINAL RESEARCH

## Effect of Denture Cleansers on Surface Roughness and Flexural Strength of Heat Polymerised Acrylic Resin – Invitro Study

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### ABSTRACT

The surface roughness of denture base fabricated with Acrylic resin is crucial in the maintenance of denture hygiene. Rough surfaces are found to accumulate microorganisms which can colonise the microirregularities leading to foul smell and also compromise the health of the oral tissues. This Study was aimed to measure the surface roughness and flexural strength of heat polymerised resin of 180 day use after its immersion in denture cleanser. Two types of heat polymerised acrylic resins Acryln – H and DPI were selected. 40 specimens were prepared out of each resins. Among 40 specimens 20 specimens are taken as a control from each of the resins. Then the specimens were immersed in distilled water and in denture cleansing tablet sodium perborate monohydrate. Surface roughness (RA) and flexural strength (S) was measured before and after immersion in denture cleanser solution. The surface roughness were increased in both Acryln-H and DPI heat cure acrylic resin materials after immersion in denture cleansers. The flexural strength were much reduced in Acryln-H material on comparing with DPI after immersion in denture cleanser.

**Key words:** Denture cleanser, surface roughness, acrylic denture

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Denture cleansing is an important measure that can prevent cross contamination and contributes to patient's oral health, denture longevity and overall quality of life.<sup>1</sup> Improper prosthesis maintenance may contribute to formation of plaque, biofilm and pathogen colonization on the tissue surface of dentures, which are the significant factors in the pathogenesis of denture stomatitis.<sup>2</sup> Patient education regarding prosthesis hygiene and maintenance, is one of the main criteria for

successful dental treatment. Daily disinfection of the prosthesis usually reduces the progression of biofilm formation on denture surfaces. There are several types of denture cleanser and mainly chemical method of cleansing is preferred nowadays. The main drawback of the denture cleansers is their detrimental effect on physical properties of denture base materials. Chemical method of cleansing is preferred nowadays. The main drawback of the denture cleansers is their

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detrimental effect on physical properties of denture base materials.

Since, these hygiene procedures have been shown to alter the physical and mechanical properties of acrylic resins, the short study was conducted to evaluate the effect of denture cleansing tablets (alkaline peroxide). Hence, the aim of this short study was to measure the surface roughness and flexural strength of heat-polymerized acrylic resin after immersion in denture cleansers, simulating a 180-day use. The hypothesis tested was that, immersion in effervescent tablets would influence the surface roughness and flexural strength of denture bases.<sup>3</sup>

## MATERIALS AND METHODS

**Specimen fabrication:** A total of 40 rectangular specimens were prepared<sup>[4]</sup> from two types of heat polymerised acrylic resin denture base materials and divided into two main groups based on heat polymerised acrylic resin.

Among 40 specimens 20 specimens is taken as a control from each of the heat polymerised acrylic resins (Acryln-H and DPI). Forty rectangular shaped wax pattern of size 65\*10\*3mm as per ISO 1567 was prepared respectively<sup>4</sup> [Figure 1a] Wax patterns were invested with dental plaster. After setting the flask halves were separated and wax was removed and cleaned. Moulds were packed with two types of heat polymerised acrylic resin (Acryln-H and DPI.)

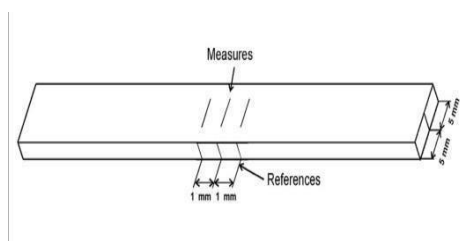


Figure 1a: Wax pattern

Figure 1b: Schematic of surface markings

The specimens were processed in a water at 74 degree Celsius for 8 hours and then increasing the temperature to 100 degree Celsius and processing

of 1 hour. After polymerisation the flasks were allowed to cool to room temperature before opening. After that resins were recovered and excess was trimmed. One surface of the resin were left unpolished and other surface was polished on wet rag wheel with slurry of pumice.

Four markings [Figure 1b] were made in unpolished surface of specimen, one in half of the width of rectangular specimen and three on length. First marking in length is half the distance of its length and other two 1mm drawn apart laterally to first connecting these points in an area on polished surface of specimen surface roughness measured<sup>3</sup> Each specimen has a separate identity marks according to type of heat cure material with numbers were marked in their respective specimen randomly, as A-1 TO A-20 for Acryln-H material in which A-11 to A-20 is control group and D-1 TO D-20 for DPI material in which D-11 to D-20 is a control group for the purpose of easy identification during assessment of surface roughness and flexural strength.

**Immersion procedure:** Out of 20 Acryln-H and 20 DPI specimens 10 from each type is selected randomly as control (A-11 to A-20, D-11 TO D-20) and both the test specimens and control specimens are immersed in beaker containing distilled water for 0+2hr, [Figure 3 a] to eliminate the residual monomer.<sup>1</sup> After immersion in distilled water the measurements are made for surface roughness and flexural strength.

The test group specimens (A-1 to A-10 and D-1 to D-10) were immersed in the solution/water containing denture cleansing tablets for six days with 30 immersions per day simulating 180 days use. Each immersion was done with time interval of 2 minutes in denture cleanser sodium peroxide solution (Clinsodent - ICPA Health products limited)



**Figure 3a:** Distilled water immersion to remove residual monomer. **Figure 3b.** Control (distilled water) and Experimental immersion (denture cleanser)

The samples are taken and dried with cotton and immersed in distilled water for 15 minute.<sup>3</sup> This

cycle was repeated for entire period of study. [Figure 3b].The control group specimens (A-11 to A-20, D-11 to D-20) were stored in distilled water for entire period of the study [Figure 9].

#### **Specimen analysis:**

##### **Surface roughness analysis**

Surface roughness is the alteration in the surface of the polished denture surface. Surf test SJ-201P Rugosimeter [Figure10]a surface analyser was used to measure surface roughness of specimens before and after immersion. The stylus of the analyser moved across the specimen surface and recorded in four makings that are made in specimens. Roughness of each specimen was calculated by arithmetic mean of the measurements. The tracing length was 2.5mm and cut-off value was 0.8mm, at 0.5 mm/s. The resolution of the data was 0.01 $\mu$ m. Alteration in surface roughness Ra was obtained by difference between roughness before and after immersion.

##### **Flexural strength**

Flexural strength represents the highest stress experienced within the material at its moment of yield. It was measured using three point bending test in DL 2000 universal testing machine [Figure11].

Three point flexural test, adopted by international standards for polymer materials, including ISO 1567:1999 Dentistry-Denture base polymers is the most common technique of measuring flexural properties of denture bases.<sup>[8]</sup> Specimens were subjected to flexions until fracture. Peak load was noted at which the specimens fracture. Flexural strength was calculated using formula  $S = 3PL/2bd^2$

S - Flexural strength

P-Peak load applied L-

span length(50mm)

b -specimen width (10mm)

D-specimen thickness(2.5mm)

##### **Statistical analysis:**

The surface roughness (Ra) and flexural strength (S) values were submitted via Microsoft excel sheet and subjected for statistical analysis using SPSS version 20. The tests applied very normality test to check the normality of data. Intragroup comparison was done using paired T test (student t test) and intergroup comparison was done using unpaired T test (students independent t test). All tests were performed using confidence level of 95% with a P value of <0.05.

## **RESULTS**

### **Surface roughness:**

The surface roughness were higher with samples after immersion in denture cleanser in both Acryln – H and DPI materials.

The overall comparison before and after immersion procedures using paired t test has significant P values for both test and control specimens.

### **Flexural strength:**

The flexural strength were significantly reduced in both type of heat polymerised acrylic resin specimen samples after immersion in denture cleanser.

The overall comparison before and after immersion procedures using paired T test has significant P values for both test and control specimens. [Table1-4]

## **DISCUSSION**

Denture cleaning being an important part in maintenance of prosthesis and reducing the oral problem, needs to be performed effectively as well as routinely. Denture cleansing methods is of two types, they are mechanical method and chemical method. Chemical method is found to be better and recommended method especially in patients with poor dexterity and in old age people. The use of chemical cleansers is usually associated with mechanical methods, and their efficacy in removing stains and reducing biofilm formation on the surface irregularities of dentures have been reported.

Clinsodent, the denture cleansing tablet is the commercial denture cleansing product containing sodium perborate as the main ingredient. This denture cleansing tablets when dissolved in water readily decomposes to form hydrogen peroxide. This peroxide solution subsequently releases nascent oxygen, which in turn cleanses the surface debris stains via effervescent action.

There are several studies that investigated the effect of denture cleanser on the physical and mechanical properties of denture base acrylic resin, and they showed that effervescent tablets are efficient in removing biofilm and stains,<sup>6</sup> but the alkaline peroxide solution alters the resin properties if not used correctly.<sup>3</sup>

Based on the results of this study, simulating the period of 180 days immersion in sodium perborate tablets, alters the physical properties such as flexural strength and surface roughness. The specimens were reported significant increase in surface roughness and decrease in flexural strength in Acryln-H material than DPI Material. But this immersion in the denture

cleansing chemical solution will not involve any change in physical, chemical and mechanical properties of the acrylic resin if it is used correctly.

Paranhos, et al. in 2013 studied the physical properties of heat polymerised acrylic resin specimens after immersion in alkaline peroxide and alkaline hypochlorite simulating a period of one and half year of use of overnight immersion and concluded that alkaline peroxide does not alter the flexural strength of specimens but causes the noticeable color change where the alkaline hypochlorite causes increase in surface roughness of the specimens after its immersion.<sup>1</sup>

**Table 01: Overall comparison before and after immersion using a paired t test**

Overall comparison		N	Baseline Mean ± S.D.	Post Test Mean ± S.D.	Mean difference	t value	p value
Surface roughness	Test	20	5.6 ± 2.15	8 ± 2.92	-2.47	-12.144	0.001**
	Control	20	5.3 ± 2.17	5.9 ± 2.15	-0.58	-10.099	0.001**
Flexural strength	Test	20	66.4 ± 4.26	44.6 ± 4.92	21.86	15.241	0.001**
	Control	20	66.2 ± 3.92	45.4 ± 3.81	20.77	20.495	0.001**

**Table 02: Comparison before and after immersion based on Acrylic materials using a paired t test**

Based on Acrylic materials used			N	Baseline Mean ± S.D.	Post Test Mean ± S.D.	Mean difference	t value	p value
Surface roughness	Acryln-H	Test	10	7.4 ± 0.93	10.6 ± 1.43	-3.1887	-13.891	0.001**
		Control	10	7.3 ± 0.90	7.9 ± 0.82	-0.5799	-9.542	0.001**
	DPI	Test	10	3.7 ± 1.12	5.5 ± 1.11	-1.7535	-19.983	0.001**
		Control	10	3.4 ± 0.85	4 ± 0.86	-0.5986	-5.798	0.001**
Flexural strength	Acryln-H	Test	10	64 ± 2.79	41.6 ± 1.23	22.4174	19.203	0.001**
		Control	10	65.1 ± 3.32	42 ± 1.14	23.064	20.786	0.001**
	DPI	Test	10	68.9 ± 4.14	47.6 ± 5.43	21.3085	7.91	0.001**
		Control	10	67.3 ± 4.32	48.9 ± 1.92	18.483	13.267	0.001**

**Table 03: Subgroup analysis between test group and control group based on type of material using unpaired t test**

		Subgroups	N	Mean	S. D.	Mean difference	T value	P value
surface roughness in µm	Baseline	Acryln -H Test	10	7.4	0.93	0.14	0.356	0.726
		Acryln- H control	10	7.3	0.9			
	post test	Acryln -H Test	10	10.6	1.43	2.75	5.247	0.001
		Acryln- H control	10	7.9	0.82			
flexural strength (MPa)	Baseline	Acryln -H Test	10	64	2.79	-1.1	-0.831	0.417
		Acryln- H control	10	65.1	3.32			
	post test	Acryln -H Test	10	41.6	1.23	-0.49	-0.926	0.367
		Acryln- H control	10	42	1.14			
surface roughness in µm	Baseline	DPI test	10	3.7	1.12	0.32	0.723	0.479
		DPI control	10	3.4	0.85			
	post test	DPI test	10	5.5	1.11	1.47	3.319	0.004
		DPI control	10	4	0.86			
flexural strength (MPa)	Baseline	DPI test	10	68.9	4.14	1.55	0.82	0.423
		DPI control	10	67.3	4.32			
	post test	DPI test	10	47.6	5.43	-1.27	-0.697	0.495
		DPI control	10	48.9	1.92			

**Table 04: Subgroup analysis between test group and control group based on type of material using unpaired t test**

		test group			control group		
		subgroups	t	p value	Subgroups	t	p value
surface roughness in $\mu\text{m}$	Baseline	Acryln -H	8.046	0.001	Acryln- H control	9.874	0.001
		DPI			DPI control		
	post test	Acryln -H	8.961	0.001	Acryln- H control	10.254	0.001
		DPI			DPI control		
flexural strength (MPa)	Baseline	Acryln -H	-3.116	0.006	Acryln- H control	-1.291	0.213
		DPI			DPI control		
	Posttest	Acryln -H	-3.421	0.003	Acryln- H control	-9.592	0.001
		DPI			DPI control		

Veeran and Maryan in 1997 compared the candida albicans cells on rough and polished surface of denture base resins and found that more cells in the rough surface. In order to avoid this and to produce smooth and flat surface on the specimens of the present study, the sand papers, wet rag wheel with slurry of pumice was used.<sup>9</sup>

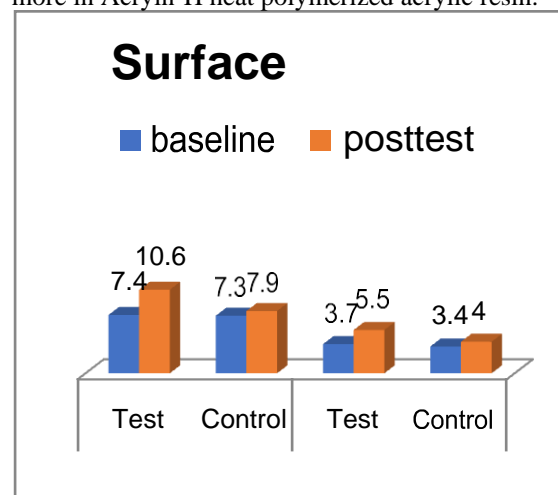
The surface roughness is of particular clinical relevance since it can affect the biofilm formation or make its removal difficult, the critical value of surface roughness is to be  $2\mu\text{m}$ , beyond which the microbial plaque and stains adheres to it.<sup>10</sup> With the use of sodium perborate chemical cleanser there is an increase in surface roughness that causes difficulty in removal of biofilm, because of inability to remove pellicle formed on acrylic surface.<sup>11</sup>

The flexure of the denture base is the important property, where the longevity of the dentures are depends on it. Karin Hermasna Neppelenbroek KH in 2005<sup>13</sup> demonstrated significant reduction of the mean hardness values of acrylic resin on immersion with sodium perborate.

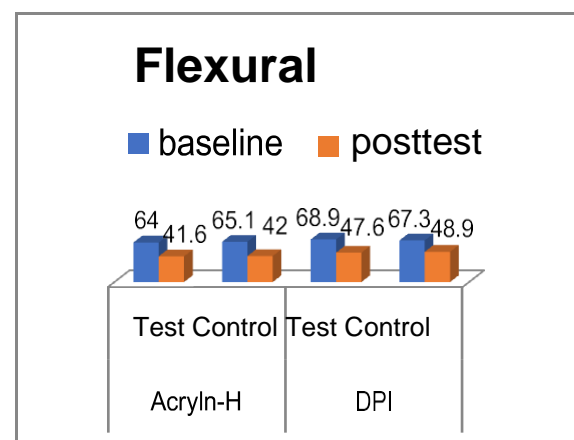
In the present study, the flexural strength were much reduced in Acryln-H material on comparing with DPI after immersion in denture cleanser. If denture cleansers lead to a reduction in strength, a higher incidence of denture fractures may occur.<sup>[11]</sup> Immersion in denture cleansers and disinfecting solutions may also decrease the flexural strength of acrylic resins because of resin fatigue and also cause mucosal irritation and allergy on daily usage.<sup>[13]</sup>

**Graph 01: Comparison of surface roughness before and after immersion based on Acrylic materials.** The surface roughness of the samples after immersion in denture cleanser were found to be increased in both type of heat polymerized acrylic resins. On comparison between the two types of heat polymerized acrylic

resin (Acryln-H and DPI) the surface roughness was more in Acryln-H heat polymerized acrylic resin.



**Graph 02: Comparison of Flexural strength before and after immersion (based on Acrylic materials).** The flexural strength were reduced with after immersion in denture cleanser in both Acryln-H and DPI Materials. On comparing the Acryln-H and DPI the flexural strength was reduced in Acryln-H.





**CONCLUSIONS**

From the above results, the heat polymerised acrylic resin specimens after immersion in denture cleansing solution there is a significant increase surface roughness in both types of heat polymerized acrylic resin materials (Acryln-H and DPI). But significant decrease in flexural strength were found in Acryln-H material on comparing with DPI after immersion in denture cleanser.

Therefore the alkaline peroxide effervescent denture cleansers should be used with caution, (i.e) once a day after brushing the dentures. The patient must follow the manufactures instructions. Thus, the cleaning method applied should not only remove the biofilm but also it should not change the properties of the acrylic resin, or produce deleterious effects.

Further studies can be directed to assess the effect of varying concentrations and immersion periods of chemical cleansers on other relevant physical properties of denture base resins, so as to help the clinician choose the best material.

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