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Original Research Paper

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EFFECTS OF DISINFECTANTS ON MECHANICAL PROPRETIES AND SURFACE MORPHOLOGY OF ACRYLIC RESINS - A DENTURE BASE MATERIAL

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ABSTRACT

An investigation was undertaken to find the effect of various disinfectant solutions on the surface hardness and surface morphology of acrylic denture base resins so as to minimize the cross infection control at the same time not compromising the physical properties of denture base resins. The effect of Four disinfectant solutions CIDEX (2% gluteraldehyde) , 5.25% Sodium hypochlorite , Sporicidin (2% glutraldehyde with phenolic buffer) and 8 % Formaldehyde were investigated on conventional heat cured acrylic denture base resin. Rectangular block specimens of- Heat cure and of size 7mm in length 3mm in thickness and 10 mm in width were made according to standard dental laboratory procedure and recommended curing time. The specimens were polished, finished and stored in water bath at 37 0 C temperature for 6 weeks. The specimens were subjected to an immersion time of 0 (control), 30 min, 1hr, 2hr, 8hr, 12hr, in four disinfectant solutions. The samples were then tested for surface hardness on Universal Testing Machine . The data then obtained were analyzed. Effect on surface morphology of heat cured acrylic resin was seen under microscope with 200 power of magnification It was shown that there was no significant effect on the surface hardness and surface morphology of heat cure acrylic resin specimen after immersion in any of the three disinfectant solutions for 12 hrs. But there was a significant reduction in surface hardness and pitting is seen on the surface of heat cured acrylic resins when it is immersed in 8 % formaldehyde for more than 2 hours . No significant effect on hardness and surface morphology is seen when immersed for 2 hours . 8% Formaldehyde produced more changes in surface hardness than sodium hypochlorite and gluteraldehyde and Glurealdehyde with phenolic buffer. Glutraldehyde and sodium hypochlorite had the least effect on the surface hardness among the three disinfectant solutions.

KEYWORDS : Disinfection, Surface hardness, Acrylic , Denture base Resins

INTRODUCTION

The need for cross-infection control in dental office and dental laboratory has become a necessity to protect the dentist, staff and patients from bacterial and viral infection such as Hepatitis B and Acquired Immune Deficiency Syndrome which are transmitted through procedures in a dental office .

These micro-organisms can spread by direct contact with blood or saliva from an infected patient in the clinical area or by indirect contact with micro-organisms from impressions, gypsum casts, and dental prosthesis in the clinical and laboratory areas. The American Dental Association and Federation Dentaire Internationale[1] recommend that at every stage of prosthesis fabrication the components should be thoroughly cleaned and disinfected before it is sent to the laboratory. They advocate immersion in a disinfecting solution for at least 8 hrs, while the British Dental Association recommends a 2 hr immersion period.

Cross contamination can occur through polishing agents and instrumentation by the use of contaminated wheel and pumice used to polish old dentures which may contaminate the new dentures, if they are not disinfected [2]. To reduce the chances of cross contamination in a new denture, it should be fully disinfected or sterilized before delivering to the patient. As a matter of routine, dentures should also be disinfected before and after each adjustment procedures. Autoclaving pumice, replacing pumice and wheel after each use, adding disinfecting agent to the pumice, using disinfecting solution for wetting pumice and using an ultrasonic cleaner to increase the biocidal activity of a disinfectant are the other precautionary measures recommended to prevent cross infection[3].

Various methods of sterilization and disinfection in the dental office have been suggested. Some of the materials and instruments used in dentistry cannot be subjected to high heat and hence chemical agents is the alternative to sterilize or disinfect them. The immersion of a denture in a suitable disinfecting solution for an adequate length of time to achieve disinfection or sterilization is a convenient, inexpensive and reliable method. Storage of the denture in disinfectant solution may reduce the portability of viral colonization on the surface of the denture base[4].

A denture base during its service is likely to be exposed to different disinfectants. It has been shown that immersion in certain disinfecting solutions can affect the physical and mechanical properties of denture base resins like flexural strength, elastic modulus and surface morphology [5]. Hardness of a material is an important property and the measurements of surface hardness of a denture base resin indicate to what extent the force applied during mastication can be resisted [6]. The effect of disinfecting solutions on surface hardness and surface morphology of denture base resin and the frequent exposure and long-term immersion of the denture base resin in various disinfecting solutions to its physical property such as surface hardness should be known before they can be recommended [7].

The purpose of this study was therefore to evaluate
1. Effect of Four disinfectant solutions on the surface hardness and surface morphology of heat cure denture base materials
2. The period of immersion time in the disinfecting solutions and its effect on the surface hardness and surface morphology of denture base resins.

MATERIALS AND METHOD

Cidex is a 2% alkaline gluteraldehyde. It is effective against bacteria, incl. Tubercle bacillus, fungi, pseudomonas, spores and virus incl. HBV and HIV. Cidex activated solution destroys 99.8% in 10 min and 100% in 45 min at 25°C on inanimate surfaces. The date of expiry will be 14 days from the date on which the cidex solution has been activated [8].

Sporicidin is a broad spectrum antimicrobial antiseptic and disinfectant that acts by destroying the cell membrane and precipitating the cell cytoplasm. Sodium hypochlorite offers intermediate level disinfection in less time (3 min) than other products. It has been shown to be more effective against micro-organisms like bacteria, fungi, spores and virus including HBV and HIV [9].

Sodium hypochlorite must be prepared daily because its useful life is considered to be just 24hrs. as chlorine gets evaporated.

Formaldehyde is again broad spectrum antimicrobial and disinfectant solution effective against aerobic and anaerobic bacteria (Figure 1)

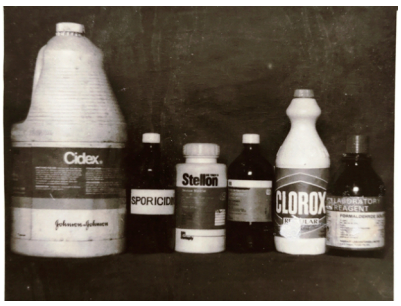

Figure 1 Material used in the study

Preparation of Specimen

A Metalic die was used to prepare specimen of size 7 cm in length , 3mm in thickness and 10 mm in width . Mould separation, packing and flasking followed the standard dental laboratory procedures. Only one side of the specimen was polished and finished by using a polishing cake. The finished specimens were then stored in a water bath at 37°C for 6 weeks which would allow the specimen to reach a 96% water saturation level10.

Testing Conditions

The 20 specimens in each group were subjected to an immersion time of 0 (control), 30 min, 1 hr, 2 hr, 8hr, 12hr, in four disinfecting solutions before mechanical testing. Control specimens were not subjected to immersion in disinfectants but kept in water for the same period.

Testing procedure

Flextural strength of all specimen were then tested on UNIVERSAL TESTING MACHINE (LLYODS INTRUMENT LIMITED) (FIGURE 2). It was measured by three point bending on UNIVERSAL TESTING MACHINE .The device consisted of a loading wedge fitted on a machine and a pair of supporting wedges placed 50 mm apart on platform of machine . (Figure 3) Each wedge has a rounded edge equivalent to ¼ inch rod. The loading wedge was set to travel at a cross head speed of 10mm / minute .

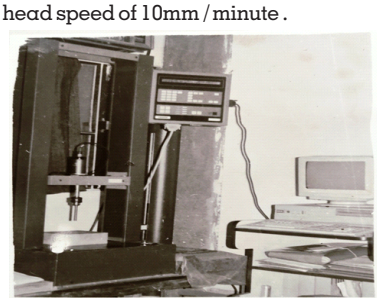

Figure 2 showing UNIVERSAL TESTING MACHINE

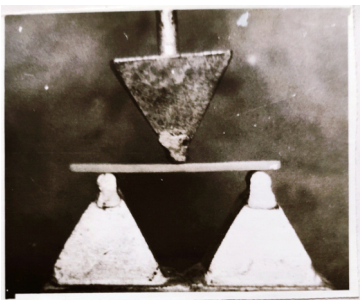

Figure 3 showing THE ACTIVE LOAD CELL

Breaking load was recorded and elongation at break was also noted for each specimen. Then flextural strength was calculated by applying formula for flextural strength.

Flextural Strength =3PL/2BD2
P = BREAK LOAD
B = WIDTH OF THE SPECIMENS = 10MM = 0.01M
L = LENGTH BETWEEN WEDGES = 5CM = 0.05M
D = THICKNESS OF THE SPECIMENS = 3MM = 0.003M
Surface of the specimen were then observed under LIGHT MICROSCOPE with 200 power of magnification to examine the morphologic changes of surface resulting from various duration of immersion in disinfectants.

The data thus obtained were analyzed.

Results

The data obtained from the forgoing investigation was statistically analyzed and the results are presented in table 1 to 5 . The data comprises the mean values obtained, together with the standard deviation and coefficient of variation. To identify any significant difference between the data obtained for the groups of materials tested a one-way analysis of variance (ANOVA) was undertaken and if a significant difference was established, the Students T test was used to determine the probability values.

Table 1 showing the difference in Mean values of various groups

	C_1	C_2	C_3	C_4
C1	-	0.65	-0.36	16.16*
C2	-0.65	-	-1.01	15.51*
C3	0.36	1.01	--	16.92*
C4	-16.16*	-15.51*	-16.92	--

L S D VALUE = 2.77 * statistically significant
Variance ratio and L S D Value between various time interval were calculated to be 13.92 and 3.66 respectively .

Table I shows, the mean surface hardness values of Heat cure resin on immersion in four disinfectant solutions at various time durations.

It is found that the surface hardness values when compared with the control gradually decreased with time on immersion in disinfectant solutions Mean Flextural strength at various time interval was calculated to be

Table 2 showing Mean Flextural strength at various time intervals

T_0	T_1	T_2	T_3	T_4	T_5	T_6
CONTROL	10 Mints	30 Mints	1 Hour	2 Hours	8 Hours	12 Hours
92.5	85.74	85.07	84.56	83.06	82.24	81.03

Difference in the mean values were calculated and presented in Table 3

Table 3 showing the difference in Means between various groups

	T_0	T_1	T_2	T_3	T_4	T_5	T_6
T_0	-	+6.76*	+7.43*	+7.94*	+9.44*	+10.26*	+11.47*
T_1	-6.76*	-	+0.67	+1.18	+2.68	+3.5	+4.71*
T_2	-7.43*	0.67	-	+0.51	+2.01	+2.83	+4.04*
T_3	-7.94*	-1.18	-0.51	-	+1.5	+2.32	+3.54
T_4	-9.44*	-2.68	-2.01	-1.5	-	+0.82	+2.03
T_5	-11.26*	-3.5	-2.83	-2.32	-4.54	-	+1.21
T_6	-11.47*	-4.71*	-4.04*	-3.54	-2.03	-1.21	-

* statistically significant

Table 3 shows the comparison among the groups – Gluteraldehyde, Glurealdehyde wth phonic buffer Formaldehyde and Sodium hypochlorite at various time duration for Heat cure (by ANOVA test) The F and P values denotes the overall significant changes in surface hardness at various time durations. It is found that there is a significant change in surface hardness of Heat cure immersed in Formadehyde disinfecant solution for more than 2 hours and a highly significant change when immersed for 10 hours.

Mean Elongation at break at various time interval was calculated to be

Table 4 showing Mean Elongation at break at various time intervals

T_0	T_1	T_2	T_3	T_4	T_5	T_6
CONTROL	10 MINTS	30 MINTS	1 HOUR	2 HOURS	8 HOURS	12 HOURS
6.971	6.183	6.114	6.00	5.89	5.93	5.92

Difference in the mean values were calculated and presented in Table 5

Table 5 showing the difference in Means between various groups

	T_0	T_1	T_2	T_3	T_4	T_5	T_6
T_0	-	+1.950*	+1.990*	+2.040*	+2.110*	+2.39*	+2.58*
T_1	-1.950*	-	+0.037	+0.090	+0.160	+0.440	+0.63
T_2	-1.990*	0.037	-	+0.050	+0.123	+0.403	+0.593
T_3	-2.040*	-0.090	-0.050	-	+0.070	+0.350	+0.54
T_4	-2.110*	-0.160	-0.123	-0.070	-	+0.28	+0.47
T_5	-2-39*	-0.440	-0.403	-0.350	-0.28	-	+0.19
T_6	-2.58*	-0.630	-0.593	-0.540	-0.47	-0.19	-

* statistically significant

Table 4 and 5 shows the test of significance results variations in Elongation at break for Formaldehyde at various time duration. It is found that there is no significant deviation of mean surface hardness values from the control till 2 hours for heat cure acrylic resins . But there is a highly significant deviation from more than 2 hours to 10 hours of immersion of heat cure .

It was noted that no change in Flextural strength and Elongation at break of heat cured acrylic resin specimens were there when immersed in Cidex , Sporicidin and Sodium hypochlorite under similar conditions.

Effect on Surface Morphology of Acrylic Resin after Immersion in four Disinfectants

It was noted that untreated specimens showed polishing grooves . Glossy appearance of specimens of acrylic resins remained for a short span when placed in 8 % Formaldehyde . After 2 hours of exposure specimens developed pitting which enhanced to bead type look in about 10 hours .

Agglomerates were observed when immersion period was extended to 12 hours .No change on the surface of acrylic Resin was observed after immersion of specimens in Cidex , Sporicidin and Sodium hypochlorite under similar conditions , when surface continued to show polishing grooves and retained its glossy look

DISCUSSION

The objective of immersing a denture in a disinfectant is to obtain a clean, decontaminated prosthesis by the destruction of microorganisms without damaging the denture base. It is desirable that the process should not involve any physical, mechanical or chemical changes in the denture. Such changes may include alteration of the surface morphology and changes in Flexural transverse strength and rigidity. This study was conducted to identify the effect of immersion in various disinfectants for 12 hours on the surface hardness and morphology of heat cure acrylic resin, to test the worst scenario, and to study the possible effect of repeated short immersions. Since most agents can disinfect in 10 min and many can sterilize in 6 hrs, a immersion time would be realistic in normal practice.

Hardness of a material is an important property. Measurements of surface hardness of a denture base resin indicate to what extent the forces applied during mastication can be resisted. Many methods of hardness measurements have been used but the most realistic approach to assessment of the hardness of a material is by measurement of its resistance to fracture. Then a logical definition of the hardness might be the "resistance of a material to fracture" and therefore, early fracture indicates softer material.

Studies on indentation resistance of denture base polymers, before and after storage in water, show that storage in water produces softening of the surface in heat-polymerized acrylic resins. This decrease in surface hardness indicates that water either combines with or more probably enters into the amorphous outer layer of the acrylic surface, which suggests a form of chemical reaction that cannot be prevented. So, the specimen were stored in a water bath at 37 0C for 6 weeks to reach a 96% water saturation level. These specimens were considered as control group for the study. The data presented in table V shows that no significant difference in surface hardness and morphology of Heat cure was found when immersed in Cidex Sporicidin or Sodium Hypochlorite disinfectant solutions for 12 hours when compared to the control group but immersion in Formaldehyde for more than 2 hours definitely decreases the strength and cause pitting on the surface of heat cure acrylic resins .

The absorption behavior of Formaldehyde on polymethylmethacrylate might provide a plausible explanation by considering the presence of capillaries in the polymers bounded by plane parallel walls of multilayered configuration .

The data obtained is in accordance with the above result and it shows that Formaldehyde produced more significant changes in surface hardness and surface morphology of Heat cured acrylic resins and Gluteraldehyde, Glutaradehyde with phenol and Sodium hypochlorite produced the least changes in surface hardness and morphology among the four disinfectant solutions.

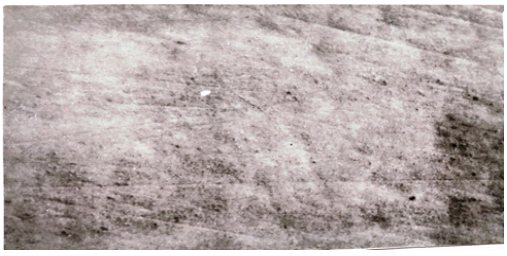

Figure 4 showing Surface of Control Specimen

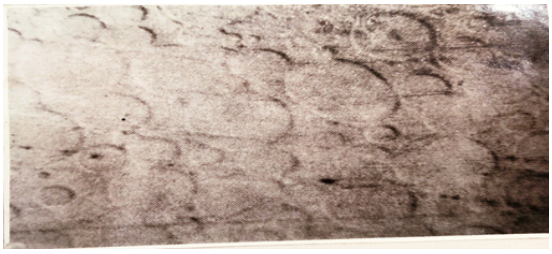

Figure 5 showing Surface of Specimen immersed in CIDEX for 8 hours

Figure 6 showing Surface of Specimen Sporicidin for 8 hours

Figure7 showing Surface of Specimen immersed in Sodium Hypochlorite for 8 hours

Figure 8 showing Surface of Specimen immersed in Formaldehyde for 8 hours

CONCLUSIONS

The following conclusions have been drawn after an investigation into the effect of immersion of heat cured acrylics in four disinfectant solutions.

1 There was no significant effect on surface hardness of the heat cure specimens after immersion in any of the three disinfectant solution (Cidex , Sporicidin and Sodium hypochlorite) for 12 hours.

2 Immersion of specimens in Formaldehyde for more than 2 hours produced a significant reduction in surface hardness and altered morphology of Heat cure resins.

3 Immersion of specimens in Formaldehyde produced more significant change in surface hardness and morphology than Sodium hypochlorite Glutraldehyde and Gluteraldehyde with phenolic buffer in longer duration of immersion .

4 Gluteraldehyde and Sodium hypochlorite had the least effect on the surface hardness and surface morphology among the four disinfectant solutions.

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