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Effect of Disnfection And Sterilization Procedures on Denture Base Materials An In-Vitro Study.

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Abstract

The Centre for Disease Control (CDC) has advised to treat every patient as a potential source of infection. The newly fabricated complete dentures should be disinfected/sterilized before insertion and after adjustment procedures. Hence, it is very important to know and understand the changes in the properties of the denture base materials which occur before and after sterilization/disinfection. This article is a study in which the linear dimensional changes, the flexural strength, colour stability and the surface analysis are compared before and after sterilization/disinfection with liquid immersion (alkaline Gluteraldehyde) and microwave methods.

Keywords: Denture Base Material, Disinfection, Sterilization.

Introduction

The Centre for Disease Control (CDC) has advised to treat every patient as a potential source of infection. Therefore the" ADA policy on HIV and AIDS" recommends that the new dentures should be disinfected/sterilized before insertion and after adjustment procedures.1,2 When patient visits the dental office to be treated with new dentures, an adjustment, reline or repair, the prosthesis will undergo a series of preparations before the work is completed. These procedures include trimming and polishing with a rag wheel and pumice. It has been shown that polishing prosthesis with a common muslin- rag wheel and pumice pan can cause contamination. Studies have shown that laboratory pumice was contaminated by oral flora and suggested soaking of pumice and rag wheel in ammonium chloride.3 The recommended disinfection/sterilization procedures for denture base materials are immersion in 2% alkaline Gluteraldehyde and microwave methods.

Studies have shown that the above disinfection/sterilization procedures can affect the strength and structure of the denture base resin.2,3,4,5,6,7

Purpose of the study

1. To evaluate the linear dimensional changes of acrylic denture base after disinfection/sterilization procedures with 2% Gluteraldehyde and microwave methods.

2. To study the effect of disinfection/sterilization procedures on the flexural properties of acrylic denture base resin.

3. To determine the effect of chemical and microwave disinfection/sterilization methods on the surface texture of acrylic denture base resin.

4. To evaluate the effect of disinfection/sterilization procedures on the color stability of acrylic denture base resin.

5. To recommend the use of an appropriate disinfection/sterilization procedures for acrylic denture base resin.

Materials and methods

Standard metal dies were specially prepared in soft brass metal, measuring 60mm in length, 10 mm in width, and 2.5 mm in thickness.(fig 1)

Fig 1: Brass metal dies in flask.

This was done to give identical samples of acrylic resins(fig 2).

Fig 2: Acrylic test samples.

Hundred specimens of heat polymerized resin were prepared and were used as follows:

20 control samples (C), 10 for dimensional stability and flexural strength and 10 for surface analysis and color stability. 20 samples, liquid disinfected (LD), 10 for dimensional stability and flexural strength and 10 for surface analysis and color stability. 20 samples , liquid sterilized (LS), 10 for dimensional stability and flexural strength and 10 for surface analysis and color stability. 20 samples , microwave disinfected (MD), 10 for dimensional stability and flexural strength and 10 for surface analysis and color stability. 20 samples, microwave sterilized (MS), 10 for dimensional stability and flexural strength and 10 for surface analysis and color stability.

Liquid disinfection (LD) specimens were immersed in a full strength solution of 2%alkaline Glutaraldehyde(fig 3) for 45 min and for liquid sterilization (LS) specimens for 10 hours at 23±1o C.

Fig 3: samples immersed in liquid disinfectant.

They were kept in an enclosed plastic container with the surface to be measured facing upwards. The volume of the disinfectant was kept constant for all the set of specimens. After immersion for the specified time, the tray was lifted from the disinfectant solution and the specimens were

rinsed with water and dried with compressed air before proceeding for testing.

Microwave disinfection/sterilization samples (fig 4) were simultaneously removed from their storage environment and were placed on a revolving turntable in a conventional microwave oven. Microwave oven was adjusted to medium output (500 W).

Fig 4: Samples placed in microwave oven.

Microwave disinfection (MD) samples were exposed for 3 min for disinfection and for 15 min for sterilization. A cup filled with 150 ml water was placed inside the oven during the disinfection/sterilization period to protect the microwave generator or magnetron from overheating as advocated.5,8,9

Testing Conditions

Specimens were evaluated for linear dimensional changes, flexural strength, surface analysis and color stability. All the tests were carried out at room temperature.

Dimensional Stability

The resulting linear changes were estimated by making measurements across the longest side (60mm) of each specimen at 3 particular points before and after disinfection. The average of three readings was reported and the difference in the measurement was calculated.

An electronic digital caliper (accuracy to 0.01 mm or 0.0005 inch – Max series, NSK, Japan) was used to measure the samples (fig 5).

Fig 5: Electronic digital caliper for sample measurement.

Flexural properties

The transverse or flexural strength of the specimens was measured by using a 3 point bend test on a testing machine attached to a 3 point bend test jig (fig 6).

Fig 6: Specimen mounted on 3 point jig for testing flexure strength.

The jig consisted a loading wedge and a pair of supporting wedges placed 50mm apart. The test specimens were centered on the test jig so that the loading wedge, set to travel at a cross head speed of 5 mm/min, engaged the center of the upper surface of the specimens. Specimens were deflected until the fracture occurred, and the load at fracture was recorded on the scale (fig 7).

Fig 7: Flexion of the specimen under loading wedge.

The values for modulus of rupture often referred to as transverse or flexural strength, reflecting the rigidity of the specimens were recorded and computed by the following equation:

FS= 3PL2bd2

Where, FS= Modulus of rupture (N/mm2),

P= Peak load exerted on specimen (N),

L= Distance between supporting wedges (mm),

b= width of specimen (mm),

d= thickness of specimen (mm).

Surface Analysis

Mean Surface roughness (Ra) of each test specimen was obtained before and after disinfection/sterilization procedures.

A surface analyzer (surtronic 3+, Taylor Hobson Pneumo, England) was used to record the data (fig 8).

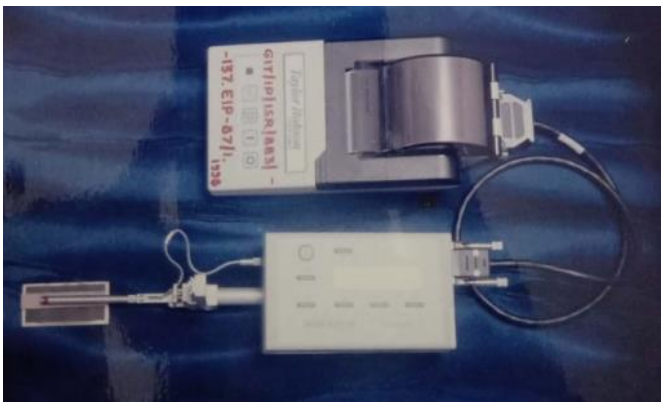

Fig 8: Sample being analysed for surface roughness by Surtronic 3+

Color Stability

A color tab was fabricated to compare the color change in test specimens before and after disinfection/sterilization procedures (fig 9 and 10).

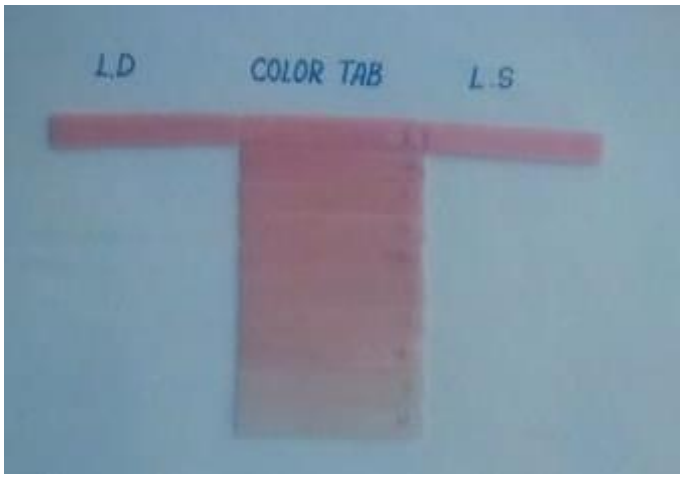

Fig 9: Specimen matched with colour tab (liquid disinfected sample).

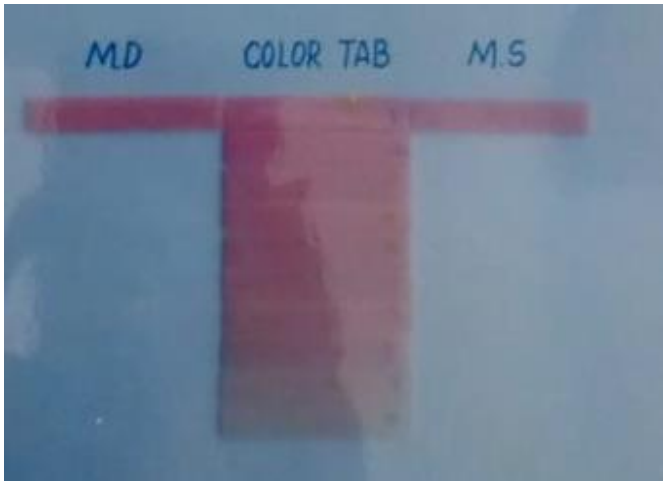

Fig 10: Specimen matched with colour tab (microwave disinfected sample).

This color tab consisted of 10 rectangular specimens of same dimensions as the test specimen. Clear acrylic was added by percentage weight to a measured quantity of pink polymethyl methacrylate (PMMA), for each of the specimens. The 1st specimen was fabricated with 100% PMMA. In the 2nd sample, 90% pink acrylic and 10% clear acrylic was used. The next sample with 80% pink

and 20% clear acrylic and so on. The last sample contained 10% pink acrylic and 90% clear acrylic. Test specimens before and after disinfection/sterilization procedures were compared with the color tab and graded accordingly.

All the results were subjected to statistical analysis.

Results

Table I Shows the mean difference in the linear measurements of the different groups before disinfection/sterilization and after disinfection/sterilization along with the standard deviation. The values for control group are the mean difference after processing and after 1 week.

Table 1: Sample: Control Length Measurement (In mm)

		After Processing				After One Week				
S.No	**Code**	**L1**	**L2**	**L3**	**AVG L**	**L1**	**L2**	**L3**	**AVG L**	**DEL L**
1	C1	60.11	60.21	60.02	60.113	60.15	60.2	60.05	60.113	-0.02
2	C2	59.49	59.47	59.52	59.493	59.57	59.47	59.53	59.523	-0.03
3	C3	59.55	59.45	59.32	59.44	59.41	59.53	59.59	59.51	-0.07
4	C4	59.7	59.9	59.77	59.79	59.75	59.93	59.77	59.817	-0.027
5	C5	59.39	59.47	59.41	59.423	59.42	59.45	59.37	59.413	0.01
6	C6	59.6	59.79	59.78	59.723	59.81	59.77	59.57	59.717	0.006
7	C7	60.16	60.11	59.89	60.053	60.12	60.09	59.9	60.037	-0.016
8	C8	59.25	59.26	59.24	59.25	59.28	59.29	59.26	59.277	-0.027
9	C9	60.22	60.2	60.13	60.183	60.29	60.38	60.23	60.3	-0.117
10	C10	59.92	59.9	59.77	59.863	59.92	59.92	59.87	59.887	-0.024

Mean DEL L - 0.028, S.D - 0.0399

Table II Shows the mean difference in the flexural strengths of the different groups before disinfection/sterilization and after disinfection/sterilization along with the standard deviation. The values for control group are the mean difference after processing and after 1 week.

Table 2: Sample: Liquid Disinfectantlength Measurement (in mm)

		After Processing				After One Week				
S. No	**Code**	**L1**	**L2**	**L3**	**AVG L**	**L1**	**L2**	**L3**	**AVG L**	**DEL L**
1	C1	59.96	60.02	59.86	59.947	59.99	59.94	59.84	59.923	0.0224
2	C2	59.52	59.44	59.39	59.45	59.42	59.46	59.38	59.42	0.03
3	C3	59.49	59.46	59.42	59.457	59.38	59.49	59.44	59.437	0.02
4	C4	59.6	59.52	59.35	59.49	59.57	59.51	59.35	59.477	0.013
5	C5	59.71	59.66	59.77	59.713	59.74	59.64	59.78	59.72	-0.007
6	C6	60.05	60.17	60.15	60.123	59.9	60.16	60.02	60.027	0.096
7	C7	59.66	59.8	59.14	59.533	59.62	59.79	59.13	59.513	0.02
8	C8	59.88	59.96	59.86	59.9	59.81	59.94	59.8	59.85	0.05

9	C9	59.98	59.77	59.11	59.62	59.96	59.77	59.1	59.61	0.01
10	C10	59.94	59.99	60.05	59.993	59.73	60	59.97	59.9	0.093

Mean Del L - 0.035, S.D - 0.0346

Table III Shows the mean difference in the surface analysis of the different groups before disinfection/sterilization and after disinfection/sterilization along with the standard deviation. The values for control group are the mean difference after processing and after 1 week.

Sample: Liquid Sterilization Length Measurement (in mm)

		After Processing				**After One Week**				
S. No	**Code**	L1	L2	L3	AVG L	L1	L2	L3	AVG L	DEL L
1	C1	59.61	59.67	59.68	59.653	59.66	59.72	59.6	59.66	-0.007
2	C2	59.69	59.99	60.03	59.993	60.06	59.97	59.99	59.99	0.003
3	C3	59.72	59.69	59.42	59.61	59.51	59.74	59.667	59.667	-0.057
4	C4	59.83	59.97	59.82	59.873	59.85	59.93	59.883	59.883	-0.01
5	C5	59.52	59.63	59.51	59.553	59.61	59.59	59.587	59.587	0.034
6	C6	59.88	59.99	60.07	59.98	60.99	58.87	59.99	59.99	0.01
7	C7	59.36	59.24	59.24	59.28	59.24	59.25	59.3	59.3	0.02
8	C8	59.17	59.92	59.93	59.673	59.91	59.89	59.847	59.847	0.174
9	C9	60.21	60.22	60.16	60.197	60.2	60.19	60.193	60.193	0.004
10	C10	59.54	59.68	59.8	59.673	59.8	59.84	59.84	59.84	0.167

Mean Del L -0.047, S.D - 0.0675

Table IV Shows the mean difference in the gradings of the color difference before and after sterilization/disinfection by the observer A, B, C.

Sample :Microwave Disinfection Length Measurement (In mm)

		Before Disinfection				**After Disinfection**				
S. No	**Code**	L1	L2	L3	AVG L	L1	L2	L3	AVG L	DEL L
1	MD1	59.51	59.51	59.49	59.503	59.48	59.51	59.57	59.52	-0.017
2	MD2	59.35	59.51	59.46	59.44	59.53	59.53	59.31	59.457	- 0.017
3	MD3	59.65	59.64	59.49	59.593	59.57	59.73	59.74	59.68	-0.087
4	MD4	60.26	60.33	60.22	60.27	60.23	60.38	60.22	60.277	-0.007
5	MD 5	59.83	60.16	60.09	60.027	59.88	60.19	60.14	60.07	-0.043
6	MD 6	59.64	59.53	59.41	59.527	59.67	59.61	59.42	59.567	-0.04
7	MD 7	59.37	59.33	59.45	59.383	59.37	59.42	59.48	59.423	-0.04
8	MD 8	59.5	59.52	59.47	59.497	59.52	59.53	59.5	59.517	-0.02
9	MD 9	59.68	59.85	59.86	59.797	59.67	59.92	60.01	59.867	-0.07
10	MD 10	59.96	60.85	60.21	60.13	60.03	60.21	60.28	60.173	-0.043

Mean Del L - 0.038, S.D - 0.0251

Table V: Sample :Microwave Sterilization Length Measurement (In mm).

		After Processing				After One Week				
S. No	**Code**	L1	L2	L3	AVG L	L1	L2	L3	AVG L	DEL L
1	MD1	59.7	59.82	59.81	59.77	59.8	59.78	59.68	59.753	0.024
2	MD2	60.08	60.44	60.01	60.177	60.18	60.36	59.9	60.147	0.03
3	MD3	59.28	59.24	59.24	59.25	59.21	59.24	59.16	59.203	0.047
4	MD4	59.66	59.37	59.37	59.54	59.61	59.57	59.37	59.517	0.023
5	MD 5	59.18	59.2	59.2	59.283	59.13	59.4	59.25	59.26	0.023
6	MD 6	59.22	59.52	59.52	59.387	59.21	59.31	59.5	59.34	0.047
7	MD 7	59.76	59.95	59.95	59.887	59.73	59.93	59.88	59.847	0.03
8	MD 8	59.76	59.96	59.96	59.92	59.81	60.01	60.01	59.943	0.023
9	MD 9	60.18	59.98	59.98	60.077	60.13	59.93	59.93	60.077	0
10	MD 10	60.21	60.23	60.23	60.293	60.17	60.34	60.18	60.23	0.063

Mean Del L - 0.026, S.D -0.0245

Table VI: Surface Analysis

		After Processing	**One Week After**	
S. No.	**Code**	CON-B	CON-A	DEL-CON
		µm	µm	µm
1	C1	0.54	0.52	0.02
2	C2	0.66	0.56	0.1
3	C3	3.2	2.96	0.24
4	C4	0.4	0.24	0.16
5	C5	0.98	0.95	0.03
6	C6	1.32	0.56	0.76
7	C7	0.8	0.8	0
8	C8	0.5	0.28	0.22
9	C9	1.02	0.62	0.4
10	C10	0.7	0.62	0.08

MEAN DEL L - 0.201, S.D - 0.2316

Table VII: Sample:Liquid sterilization

		Before Sterilization	**After Sterilization**	
S. No.	**code**	**LS-B**	**LS-A**	**DEL- LS**
		µm	**µm**	**µm**
1	LS1	0.6	0.86	-0.26

2	LS2	0.96	1.18	-0.22
3	LS3	0.98	0.98	0
4	LS4	0.54	0.7	-0.16
5	LS5	0.42	0.42	0
6	LS6	0.9	1.2	-0.3
7	LS7	0.72	0.74	-0.02
8	LS8	1	1.02	-0.02
9	LS9	0.93	0.98	-0.05
10	LS10	0.8	0.88	-0.08

MEAN DEL L – 0.111, S.D - 0.1145

Table VIII: Sample :Liquid sterilization

		Before Sterilization	**After Sterilization**	
S. No.	**Code**	LS-B	LS-A	DEL- LS
		µm	µm	µm
1	LS1	0.38	0.46	-0.08
2	LS2	0.26	0.32	-0.06
3	LS3	0.86	0.98	-0.12
4	LS4	0.38	0.74	-0.36
5	LS5	0.34	0.4	-0.06
6	LS6	0.58	0.75	-0.17
7	LS7	0.36	0.24	0.12
8	LS8	0.42	0.46	-0.04
9	LS9	1.24.	1.37	-0.13
10	LS10	0.7	0.96	-0.26

Mean Del L – 0.116, S.D - 0.1301

Table IX:Sample- Microwave disinfection

		Before Sterilization	**After Sterilization**	
S. No.	**Code**	LS-B	LS-A	DEL- LS
		µm	µm	µm
1	MD1	0.48	0.38	0.1
2	MD2	0.84	0.68	0.16
3	MD3	0.66	0.74	-0.08
4	MD4	0.86	0.54	0.32
5	MD5	0.66	0.64	0.02
6	MD6	0.68	0.64	0.04

7	MD7	0.72	0.67	0.05
8	MD8	0.5	0.4	0.1
9	MD9	0.6	0.4	0.2
10	MD10	0.8	0.58	0.22

MEAN DEL L – 0.113, S.D - 0.1153

Table X:Sample :Microwave sterilization

		Before Sterilization	**After Sterilization**	
S. No.	**Code**	**LS-B**	**LS-A**	**DEL- LS**
		µm	µm	µm
1	MD1	0.67	0..55	0.12
2	MD2	0.58	0.54	0.04
3	MD3	0.22	0.19	0.03
4	MD4	1.04	0.72	0.32
5	MD5	0.86	0.68	0.18
6	MD6	1.04	0.96	0.08
7	MD7	0.72	0.56	0.11
8	MD8	0.5	0.39	0.08
9	MD9	0.38	0.46	0.06
10	MD10	1.74	1.8	0.09

Mean Del L – 0.09, S.D - 0.1178

Flexura L Strength

Table XI: Sample: control

S. No.	**code**	**L**	**d**	**b**	**P**	**FS**
1	C1	50	2.74	10.363	60	89.674
2	C2	50	2.757	10.177	50	75.159
3	C3	50	2.743	10.313	53	79.422
4	C4	50	2.687	10.37	53	82.312
5	C5	50	2.743	10.23	50	75.534
6	C6	50	2.55	9.833	49	89.111
7	C7	50	2.84	10.693	70	94.376
8	C8	50	2.803	10.28	65	93.578
9	C9	50	2.7	10.26	45	69.958
10	C10	50	2.71	10.287	54	83.113

Mean FS – 83.224,S.D - 7.781

Table XII: Sample : liquid disinfection

S. No.	Code	L	d	b	P	FS
1	LD1	50	2.817	10.75	65	88.6
2	LD2	50	2.713	10.597	51	76.031
3	LD3	50	2.757	10.28	66	98.215
4	LMD4	50	2.877	10.917	66	84.93
5	LD5	50	2.827	10.687	73	99.384
6	LD6	50	2.7	10.06	54	85.619
7	LD7	50	2.763	10.237	59	87.785
8	LD8	50	2.767	10.913	61	84.892
9	LD9	50	2.787	10.483	68	97.107
10	LD10	50	2.73	10.58	60	88.479

Mean FS – 89.104, S.D - 7.2521

Table XIII: Sample: liquid sterilization

S. No.	Code	L	D	B	P	FS
1	LS1	50	2.713	10.33	406	70.349
2	LS2	50	2.563	10.29	52	89.452
3	LS3	50	2.83	10.55	64	88.076
4	LS4	50	2.6	10.607	48	77.84
5	LS5	50	2.74	10.517	58	85.415
6	LS6	50	2.743	10.47	72	106.28
7	LS7	50	2.84	10.573	70	95.448
8	LS8	50	2.83	10.51	62	85.648
9	LS9	50	2.73	10.323	64	96.724
10	LS10	50	2.73	10.047	56	86.962

MEAN FS – 88.219, S.D - 9.9742

L- Distance between supporting wedges (in mm)

D – Thickness of the specimen (in mm)

B- Width of the specimen (in mm)

P - Peak load exerted on specimen (N)

FS - Modulus of rupture (N/sq.mm)

FLEXURAL STRENGTH

Table XIV:Sample : microwave disinfection

S. No.	Code	L	D	B	P	FS
1	MD1	50	2.673	9.777	52	86.557
2	MD2	50	2.87	10.553	70	93.64
3	MD3	50	2.86	10.12	56	78.664
4	MD4	50	2.8	10.45	57	80.899
5	MD5	50	2.583	10.387	46	77.183
6	MD6	50	2.717	10.067	57	89.186
7	MD7	50	2.817	10.297	63	89.652
8	MD8	50	2.953	10.18	68	89.071
9	MD9	50	2.87	10.76	69	90.526
10	MD10	50	2.77	10.293	61	89.811

MEAN FS – 86.519, S.D - 5.5926

Table XV: Sample: microwave sterilization

S. No.	Code	L	d	b	P	FS
1	MD1	50	2.877	10.08	61	85.014
2	MD2	50	2.767	10.103	57	85.686
3	MD3	50	2.83	10.497	68	94.053
4	MD4	50	2.817	10.487	60	83.835
5	MD5	50	2.7	10.18	58	90.877
6	MD6	50	2.677	10.03	60	97.063
7	MD7	50	2.807	10.607	66	91.827
8	MD8	50	3.07	10.217	78	94.188
9	MD9	50	2.92	10.713	72	91.655
10	MD10	50	2.7	9.957	53	84.903

MEAN FS – 89.91, S.D - 4.6913

L- Distance between supporting wedges (in mm)

D- Thickness of the specimen (in mm)

B- Width of the specimen(in mm) .

P - Peak load exerted on specimen (N)

FS - Modulus of rupture (N/sq.mm)

Colour Analysis

Table XVI: Observer A

S.No.	LD	LS	MD	MS
1	2	1	1	1
2	1	1	1	1
3	1	1	1	1
4	1	2	1	1
5	2	1	1	1
6	1	1	1	1
7	1	2	1	1
8	1	1	1	1
9	1	1	1	1
10	1	1	1	1

Percentage change: 8%

Table XVII: Observer B

S. No.	LD	LS	MD	MS
1	1	1	1	1
2	1	2	1	2
3	2	1	1	1
4	1	2	1	1
5	2	2	1	1
6	1	1	1	1
7	1	2	1	1
8	1	1	1	1
9	1	1	1	1
10	1	1	1	1

Percentage change: 12%

TableXVIII: Observer C

S. No.	LD	LS	MD	MS
1	1	1	1	1
2	1	1	1	1
3	1	1	1	1
4	2	1	1	2
5	1	1	1	1
6	1	1	1	1
7	1	1	1	1

8	1	2	1	1
9	1	2	1	2
10	1	1	1	1

Percentage change: 10%

Average percentage change: 10%

Linear Measurement

Group	Mean deviation	Standard deviation
Control	-0.0283	0.039
Liquid disinfection	0.0349	0.035
Liquid sterilization	-0.0472	0.067
Microwave disinfection	-0.0384	0.025
Microwave sterilization	0.0264	0.024

F=8.56, P> 0.05

Flexure Strength

Group	Mean deviation	Standard deviation
Control	83.22	8.32
Liquid disinfection	86.52	5.59
Liquid sterilization	89.92	4.68
Microwave disinfection	89.10	7.52
Microwave sterilization	88.22	9.98

F= 1.286, P> 0.05

Surface Analysis

Group	Mean deviation	Standard deviation
Control	0.201	0.23
Liquid disinfection	-0.111	0.11
Liquid sterilization	-0.116	0.13
Microwave disinfection	0.113	0.12
Microwave sterilization	0.09	0.12

F= 9.107, P> 0.001

Discussion

Since 1963 many studies on cross contamination involving prosthesis in dental laboratory were reported by Katbarg10, kahn11 D. Larato12, R.L. Leung13, and William14. They all agreed that the pumice pan was the major source of contamination. Fisher15 and William14 have pointed the wide distribution of contaminated air following polishing of dentures and the microorganisms were recovered from the respiratory system of the person's working in dental laboratory. Therefore James Katburg10 suggested the use of sterile pumice and rag wheels. Fisher et al15 have done extensive studies on methods of decreasing the pumice splatter and contaminated aerosol from dental polishing lathes. Despite

the efforts to minimize contamination and cross-contamination, still the laboratory pumice pan continued to be a major source of contamination. Clare Connor16 opined that the microbe laden dentures have been found to be the major source of contamination in dental laboratory. Therefore he suggested the use of 2% Glutraldehyde solution along with the ultra sonic bath to enhance the affect of biocidal action of disinfectants. A 2% Gluteraldehyde is almost universally recognized as the best and most effective immersion disinfectant/steriliant solution provided it is buffered to an ph. It has high biocidal activity and broad antimicrobial spectrum within 20-30 minutes, sporicidal after 7-10 hours of exposure at room temperature, has low surface tension, penetrates blood, pus, and organic debris, has prolonged activated life and will not degrade rubber and plastic items during prolonged immersion and is recommended for heat sensitive items. The time schedule for liquid in disinfection/sterilization procedures is the present study i.e. 45 minutes for disinfection and 10 hours for sterilization were followed as per the manufacturers recommendations as well as the recommendations of the Council on Dental Materials, Instruments and Equipments and Council on Dental Practice and Council on Dental Therapeutics.17 The microwave disinfection/sterilization schedules i.e. 3 minutes for disinfection and 15 minutes for sterilization are stated to be adequate.18,9 According to the plastic encyclopedia, phenol based disinfectants should not be used for resins. This statement substantiated by studies by Arlo H. King19 who reported that soaking of resin in phenol buffered disinfectant caused surface pitting and swelling of acrylic resins. The dimensions of specimens samples selected for the present study were as per the ADA specification i.e. 60x10x2.5 mm.20 The testing of the samples for linear changes was done by making measurements across the longest side (60 mm) of each specimen, before and after disinfection/sterilization procedure using an electronic digital caliper with an accuracy of 0.01 mm. (Max series, N.S.K. Japan) The means of linear changes reported were subjected to statistical analysis. The Analysis of variance (ANOVA) revealed significant difference between means of groups. Liquid sterilization, microwave disinfection groups differed from other groups (-0.0472 and -0.0384 respectively). It is well established that storage of acrylic resin in water induces linear change.21,22 The results of present study (-0.028) with control group confirms this. The linear change seen with the liquid sterilization group i.e. -0.047 confirms with the results from the study of Gregory Polyzois5 i.e. -0.005 to 0.03%. This linear expansion partially compensates the overall polymerization shrinkage. The microwave disinfection group showed a small increase in linear dimension (-0.038). Because the microwave environment was initially water saturated, the samples would be expected to imbibe water, with a subsequent increase in length. The amount of change occurred (0.03%) was small and not clinically important when compared to processing changes (0.3-0.4%). The results of the microwave disinfetion from the present study coincide with the results of David R. Burns10 (i.e. 0.02-0.03%). All the above mentioned results, though statistically significant are clinically not significant. Flexural strength was estimated by using the 3 point bend test specified by the International test standard. The mean flexural strength obtained in the present study varied from 88.22 N/mm2 to 89.92 N/mm2. The ANOVA showed neither disinfection/sterilization nor the immersion of microwave method affected flexural strength of the specimen. These results were in agreement with the studies conducted by Shen et al7 and Gregory Polyzois.5 Shen et al studied the effects of Gluteraldehyde on both flexural strength and rigidity of denture base

resins and reported that the flexural strength remained unaltered even after 12 hours of immersion. Asad et al23 reported the same for 7 days. Since flexural strength depends on the bulk of the material and the insignificant strength change in the flexural strength indicates that the bulk of the material was not affected by the disinfectant/steriliant. A C Pavarina et al24 and Iara Augusta Orsi et al25 conducted a study which concluded that transverse strength was not affected after immersion in the disinfectants for the immersion periods tested. Rafael Leonardo Xediek found that the repeated simulated microwave disinfections decreased the Knoop hardness of resins but the flexural strength was similar for all tested resins.26 Surface roughness was analyzed by a surface analyzer (Surtronics 3+, Taylor Hobson Pneumo. England). Ana Lucia Machado et al found that disinfection by immersion in sodium perborate or microwave irradiation did not adversely affect the hardness of all materials evaluated.27 Karin Herman et al found out that specimens exhibited significantly lower hardness values after disinfection regardless of the disinfectant solution used.28 Mean arithmetic roughness (Ra) is the universally recognized and most used international parameter of roughness. It is the arithmetic mean of the departures of the profile from the mean line and was used to assess surface changes. The results obtained revealed statistically significant surface changes having occurred with liquid disinfection and liquid sterilization groups (means -0.111 and -0.116 respectively) when compared with other groups. The results of the present study are in agreement with the study by Tsun Ma2 who found that the statistically significant differences (0.03-0.06 um) were shown between the control and disinfected/sterilized samples for Ra values. He concluded that all disinfectants produced an increase in roughness. Though the results showed statistically significant changes, they are clinically not significant. Chiayi Shen7 who conducted a study on the effects of Gluteraldehyde base disinfectants on denture base resins concluded that no appreciable change on the surface was seen after 12 hours immersion in Cidex 7 solution. But he used a light microscope, whereas a surface analyzer which was used in the present study, is more precise. The discoloration of a denture base resin can be determined visually under adequate illumination with bright daylight. For evaluating the color stability, the samples were compared for the color change with the color tab visually by 3 observers. Each sample was placed on a white background as suggested by Powers.4 The samples were matched with the color tab and were graded accordingly.

Stanley J. Mc Neme et al.4 estimated the color change by the comparing the immersed part of the sample (in disinfectants) with the controlled part of the same sample. Since the same method was not applicable to the microwave disinfection/sterilization technique, a color tab was prepared as described in the methodology and was used for comparison for color for both the techniques i.e. liquid and microwave disinfection/sterilization.

As per the results obtained from the present study, no observable color change was noticed by all the 3 observers. According to them, 90% of the samples were matching with the first tab i.e. made from 100% pink acrylic. The results of the present study were in agreement with the results of Stanley J. Mc Neme

et al4 who concluded that 1% sodium hypochlorite and 2% Cidex disinfectants produced the least color change and with studies of Tsun Ma et al2 who concluded that insignificant color shift of denture base resins with short and long term immersion in 2% alkaline Gluteraldehyde. The acrylic (PMMA) denture base which has to undergo repeated disinfection/sterilization procedures during its functional lifetime should remain unaffected. Most often

the denture base material is not shown through the oral cavity during speech or smiling, therefore the color change is not that critical when compared with other important properties like linear dimension, flexural strength and surface roughness. Any change in the linear dimension of the denture base can affect the fit of the denture, but the results obtained from the present study and the previous reports suggest, that both disinfection/sterilization procedures irrespective of the method (immersion or microwave) used do not affect the dimensions of the resin. Whatever the minimum changes shown statistically, were not of clinical significance. Flexural strength is another important property of denture base resins which should remain unaltered during the disinfection/sterilization procedure as the denture is subjected to more flexion than compression during mastication. The present and the previous reports suggest that the flexural strength remains unaltered during disinfection/sterilization procedures. Flexural strength depends on the bulk of the material and the insignificant change in the flexural strength indicates that the bulk of the material is not affected and no material is lost from the surface during these procedures. It is a known fact that the altered surface of the denture, especially on the impression side, can affect close tissue adaptation which can result in loss of retention. Another drawback of the surface roughness is that, it can promote accumulation of soft plaque into the roughened area causing stomatatitis, if not maintained properly by the patient. The present study showed that the surface of the denture base acrylic remained unaffected after microwave disinfection/sterilization procedures, but showed statistically significant surface roughness, more with liquid sterilization. However the above changes were clinically not significant. Color stability of the denture is not critical as already mentioned; that the denture is seldom seen through the oral cavity and any slight color change can be masked by the background affect of the tissues of the oral cavity (pink mucosa, lips and cheeks) from which it is reflected. The results from the previous29 and the present study showed that no observable color change was noticed after disinfection/sterilization procedures. Based on the results obtained from the present study, which were supported by the previous reports 23,30,2,4,5, it can be suggested that liquid disinfection/sterilization procedures can be carried out in spite of the surface changes seen which were clinically not significant, and it can be recommended that Microwave disinfection/sterilization procedures can be safely carried out with denture base material (PMMA), without any significant changes in their physic mechanical and chemical properties.

Conclusion

All the tests specimens exhibited the least linear changes during disinfection/sterilization procedures, which were clinically not significant. The flexural properties were not affected by disinfection/sterilization procedures. The surface roughness of all the specimens remained unaffected except with the liquid disinfection/sterilization groups which were clinically not significant. All the specimen samples maintained the color stability after disinfection/sterilization procedures. Both the Immersion and Microwave methods can be recommended for disinfection/sterilization of acrylic denture base resins. However the microwave method seems to be a reliable alternative with the added advantage of shorter time.

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