

Comparative evaluation of sodium hypochlorite and microwave disinfection on dimensional stability of denture bases

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PURPOSE. To compare the effect of sodium hypochlorite and microwave disinfection on the dimensional stability of denture bases without and with relining. **MATERIALS AND METHODS.** A brass die was prepared by simulating an edentulous maxillary arch. It was used to fabricate 1.5 mm and 3 mm of thickness denture bases ($n = 40$). The 1.5 mm of thickness-specimens ($n = 20$) were relined with 1.5 mm of autopolymerizing relining resin. Five holes were prepared over crest of ridge of brass die with intimately fitting stainless steel pins which were transferred to the intaglio surface of specimens during fabrication of denture bases. For calculation of dimensional changes in denture bases, differences between the baseline area before and after disinfection of the specimens were used. The denture bases without and with relining were divided into 2 groups (each $n = 20$). Data were analyzed using student paired 't' and unpaired 't' test. **RESULTS.** Microwave disinfection produces significant shrinkage in both denture bases without relining ($t = 17.16$; $P < .001$) and with relining ($t = 14.9$; $P < .001$). Denture bases without relining showed more shrinkage when compared with relined denture bases after microwave disinfection ($t = 6.09$; $P < .001$). The changes in dimensional stability after sodium hypochlorite disinfection were not significant for both denture bases without relining ($t = 2.19$; $P = .056$) and denture bases with relining ($t = 2.17$; $P = .058$). **CONCLUSION.** Microwave disinfection leads to increased shrinkage of denture bases without and with relining. Chemical disinfection with sodium hypochlorite seems to be a safer method of disinfection with regards to physical properties such as changes in dimensional stability. [J Adv Prosthodont 2012;4:24-9]

KEY WORDS: Disinfection; Denture Bases; Sodium Hypochlorite; Microwave

INTRODUCTION

Dental prostheses are exposed to normal oral microbial flora such as viruses, bacteria, and fungi. While adjusting or repairing these prosthesis, dental personnel may be at risk of acquiring infections.¹⁻³ Adequate maintenance of removable prostheses is necessary for denture wearers to have an esthetic, odor free appliance and good oral health. Oral problems related to poor hygiene of dentures indicate the needs to establish a disinfection protocol that is effective, clinically viable, inexpensive and easy to comply with. Several studies have focused on disinfection of dental prostheses. Chemical disinfection of dentures is commonly achieved by soaking it in an alkaline glutaraldehyde, sodium hypochlorite, aqueous formaldehyde or enzymatic solutions.⁴ More recently, microwave irradiation also being considered as one of the method of denture sterilization/disinfection instead of chemical solutions because it

requires no special storage, has no expiration date and does not induce resistance to *Candida albicans*.⁵ The available disinfection methods for complete dentures are still controversial because they might alter some material properties like color, hardness, roughness, dimensional stability, and flexural properties which may have an influence on the clinical outcome.⁶

Retention of denture is one of the important factors for the preservation and health of underlying tissues. This can be achieved by intimate adaptation of denture base to its underlying supporting structure. During its use, in addition, progressive alveolar resorption may affect retention and stability of dentures. In order to enhance the adaptation of denture, it needs to be relined or remade. The simple way to readapt the denture base to its supporting tissues by using the autopolymerizing relines acrylic resins.⁷ Ideally, a disinfection method should not affect properties of the denture base and denture relining materials. To the best of our knowledge, there is no study that

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reports effect of sodium hypochlorite on dimensional stability of acrylic resin. The studies on the effect of microwave disinfection methods on dimensional stability of acrylic resin showed conflicting results. Some studies reported that microwave disinfection caused changes in dimensional stability,⁵⁻⁸ while others did not report any change in dimensional stability.⁹⁻¹² Hence, this study was aimed to comparatively evaluate the effect of sodium hypochlorite and microwave disinfection on the dimensional stability of denture bases without relining and denture bases with relining.

MATERIALS AND METHODS

One autopolymerizing relining resin (Ufi Gel hard C, Voco, Germany) and a heat-polymerized acrylic resin (DPI, Dental materials, Mumbai, India) was selected for the study. Ufi Gel hard C is direct hard permanent relining material mixed from the cartridge, which is composed of polymethacrylate. It is free from methylmethacrylate. In total, 40 test denture bases were fabricated. Out of which, 20 denture bases were without relining and 20 denture bases were with relining. A brass die was prepared by simulating an edentulous maxillary arch without any undercuts. It was used to fabricate denture bases without and with relining (Fig. 1). Five parallel holes were made to determine the linear dimensional stability. Each of which was 3-mm-deep and 2.1-mm in diameter at five locations viz. at mid-line, canine and first molar region on both side on the crest of the ridge of brass die. The pins (2.0 mm × 4.5 mm) with pointed head having intimate fit were used to serve as reference points as A, B, C, D and E.

Silicone 'mould-1' using the brass die was prepared in vinylpolysiloxane duplicating material which was used to get such 40 identical master stone cast (Fig. 2). A denture base wax pattern was prepared on the standard brass cast die having 3 mm of thickness using base plate wax for the fabrication of denture bases without relining. To allow the fabrication of the denture bases without relining, a denture base pattern

was waxed on the brass standard cast with 3 mm thick base plate wax. A new 'mould-2' was prepared using the master dies having wax spacer of 3 mm- thickness adapted over it and vinylpolysiloxane duplicating material (Fig. 3). This mould was used to prepare all twenty 3 mm denture bases. Two holes 'a' and 'b' approximately of 3 mm diameter were prepared in the 'mould-2' for injection and drainage of excess wax. The master stone cast was then positioned in silicone 'mould-2'. Master stone cast was identical to brass die. So there was 3 mm space between stone cast and mould-2, which was filled by injecting molten wax through hole 'a'. Similar procedure was followed to obtain all twenty 3 mm tip wax patterns. Then all wax patterns of denture bases along with its corresponding cast was flaked in Type III dental stone using conventional flasking procedures. Dewaxing was done after one hour. To ensure the complete removal of wax, the cast was cleaned with boiling water and liquid soap. Polymer and monomer was then taken in the ratio of 3:1 by volume and mixed to get acrylic dough, which was then packed in to the mould. After trial packing, the pins were placed in the holes such that their heads should be towards the cast holes (Fig. 4). Final closure of the flask was done under the hydraulic press using 1100 kg pressure and kept for 2 hours under the same pressure. The test denture base was

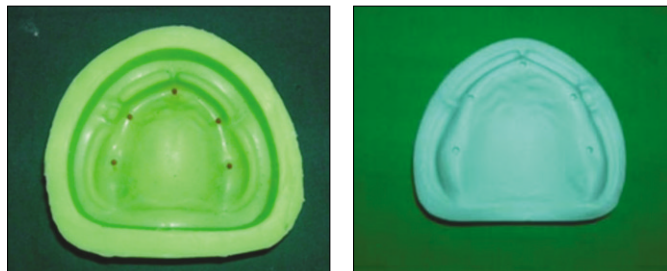


Fig. 2. The silicone mould-1 and master stone cast retrieved using mould-1.



Fig. 1. Master brass die.



Fig. 3. Silicone mould-2.

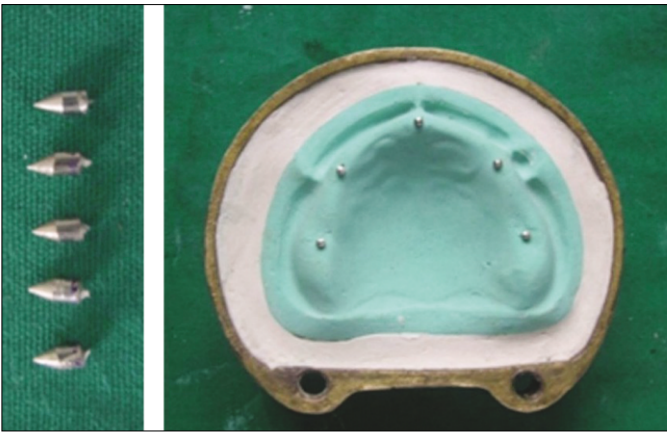


Fig. 4. Stainless steel pins placed in position after trial closure.

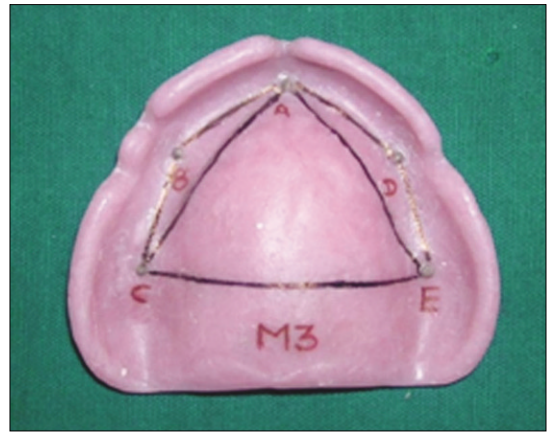


Fig. 5. Denture base without relining.



Fig. 6. The 1.5 mm larger cast retrieved using mould-3.

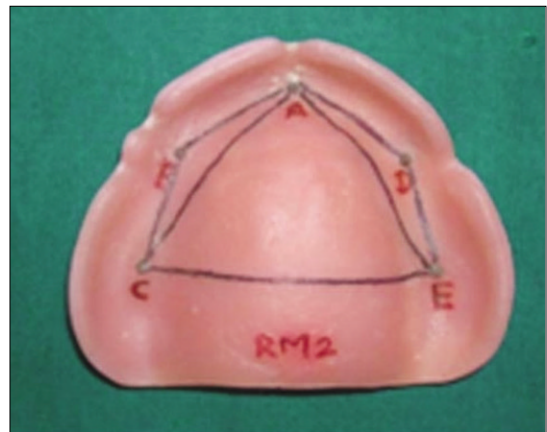


Fig. 7. Denture base with relining.

polymerized utilizing long curing cycle for 8 hours at 74°C temperature. The flask was opened after bench cooling. The test denture base along with the master stone cast was retrieved carefully and finished (Fig. 5). It was then polished following the standard procedure and kept in the distilled water at $37 \pm 1^\circ\text{C}$ for 8 days in incubator before subjecting to disinfection procedure.

For the fabrication of relined denture base specimens, 1.5 mm-thick base plate wax was adapted over the standard brass cast. This master die with the adapted wax was used to prepare another silicone 'mould-3', which was used to obtain 20 stone casts (Fig. 6). These casts were 1.5 mm larger than the master brass die on tissue surface. Melted wax was injected in silicone 'mould-1' to get 1.5 mm thick denture base. The 1.5 mm-spaced dental stone cast was placed into the mould to get 1.5 mm-thick-waxed record base. The 1.5 mm-wax denture base along with its respective cast was flaked with dental stone as previously described. These denture bases were stored in

water at $37 \pm 1^\circ\text{C}$ for 8 days and then submitted to relining procedure. These denture bases having 1.5 mm-thickness were returned to the master stone casts and were sealed using wax. Flasking procedure was done as described previously. Dewaxing procedure was completed to eliminate all wax around the denture bases. The pins were then placed in the holes on the crest of the ridge following similar procedure described earlier. The bonding agents for Ufi Gel hard C were applied on the intaglio surface of the denture base. The reaction time 30 seconds was given before addition of the resin. The relining resin was injected onto the intaglio surface reline area of treated denture base with automixing gun. The flask closure was completed and adjusted over the hydraulic press to deliver a pressure of 450 kg for 7 minutes till polymerization of relined material occurred. Such twenty relined denture bases were prepared using similar procedure (Fig. 7). These denture bases were kept in distilled water at $37 \pm 1^\circ\text{C}$ for 8 days in incubator before subjecting to disinfection procedure.

All specimens ($n = 40$) were divided into two groups ($n = 20$) as follows:

Group 1- Sodium hypochlorite disinfection (immersion in 0.525% for 10 minutes)

1a- Denture bases without relining ($n = 10$).

1b- Denture bases with relining ($n = 10$).

Group 2- Microwave disinfection (650 W for 6 minutes)

2a- Denture bases without relining ($n = 10$).

2b- Denture bases with relining ($n = 10$).

For sodium hypochlorite disinfection, freshly prepared 0.525% of sodium hypochlorite was used. Each sample was then kept in 200 ml of 0.525% of sodium hypochlorite for 10 minutes.¹³ For microwave disinfection, a domestic microwave oven was used for carrying out disinfection of the samples. A sample was kept in 200 ml of distilled water and then oven was set at 650 W for 6 minutes.¹⁴ After every disinfection procedure, the measurements between reference pins were taken before and immediately after disinfection procedure. Travelling microscope was used to measure the distance between the selected reference points. Single operator did all measurements by taking into account the least count of 0.01 mm of travelling microscope. To calculate the baseline area ABDCEA, we added the area of 3 triangles viz. ΔABC , ΔADE , and ΔACE of each sample denture base before and after disinfection. The area of each triangle with unequal sides was calculated using the following equation.^{7,15,16}

$$\Delta = \sqrt{S(S-P)(S-Q)(S-R)}$$

Where $S = (P + Q + R) / 2$

And P, Q, and R are the lengths of the sides of the triangle.

All the data were subjected to statistical analysis. Computation was done by SPSS 17.0 software for windows (SPSS Inc., Chicago, IL, USA). Comparative evaluation was done in between the test groups, 1) disinfection by sodium hypochlo-

rite and 2) disinfection carried out using microwave for both denture bases without and with relining. The descriptive analysis was done to obtain mean and standard deviation of surface area of denture bases. The paired 't' test was carried out to evaluate the effect of disinfection methods on dimensional stability before and after the disinfection procedure (i.e. comparison within the same group of disinfection methods). The unpaired 't' test was done to compare the dimensional changes between two different disinfection methods (i.e. comparison between sodium hypochlorite and microwave disinfection methods).

RESULTS

Table 1 shows the difference in total surface areas before and after sodium hypochlorite and microwave disinfection of denture bases without and with relining. Table 2 shows the effect of sodium hypochlorite and microwave disinfection on dimensional stability of denture bases with and without relining. After sodium hypochlorite disinfection, this difference was not significant for both denture bases without relining ($t = 2.19$; $P = .056$) and denture bases with relining ($t = 2.17$; $P = .058$) (Fig. 8). While after microwave disinfection, this difference was highly significant for both denture bases without relining ($t = 17.16$; $P < .001$) and denture bases with relining ($t = 14.90$; $P < .001$) (Fig. 9). Table 3 shows the comparison of dimensional stability of denture bases without and with relining after disinfection by sodium hypochlorite and microwave disinfection. This clearly shows that the microwave disinfection produced significant change in dimensional stability of denture bases without relining when compared with dimensional stability of denture bases with relining ($t = 6.09$; $P < .001$) (Fig. 10).

Table 1. Difference in total surface areas before and after sodium hypochlorite and microwave disinfection of denture bases without and with relining

Denture bases without relining for sodium hypochlorite disinfection	Difference in total surface area after disinfection*	Denture bases with relining for sodium hypochlorite disinfection	Difference in total surface area after disinfection*	Denture bases without relining for microwave disinfection	Difference in total surface area after disinfection*	Denture bases with relining for microwave disinfection	Difference in total surface area after disinfection*
C1	0.0246	RC1	0.0444	M1	-5.3367	RM1	-2.8575
C2	0.0156	RC2	0.0314	M2	-5.1358	RM2	-2.1776
C3	0.0132	RC3	0.0132	M3	-4.795	RM3	-3.2211
C4	0.1450	RC4	0.0146	M4	-5.5373	RM4	-3.0082
C5	0.0195	RC5	0.0149	M5	-7.2305	RM5	-2.9502
C6	0.5160	RC6	0.0055	M6	-6.4900	RM6	-3.869
C7	0.1516	RC7	0.1516	M7	-5.2577	RM7	-3.3601
C8	0.0146	RC8	0.0164	M8	-5.7597	RM8	-3.6048
C9	0.0911	RC9	0.0033	M9	-7.7867	RM9	-4.9327
C10	0.0742	RC10	0.0098	M10	-7.7776	RM10	-3.9159

(-) shows shrinkage, (+) shows expansion, *All values in cells are square millimeter

Table 2. Effect of sodium hypochlorite and microwave disinfection on dimensional stability of denture bases with and without relining

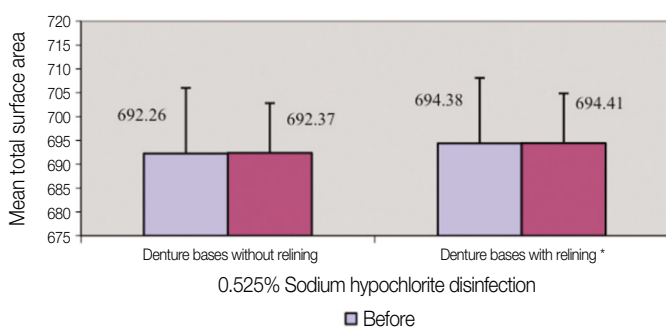
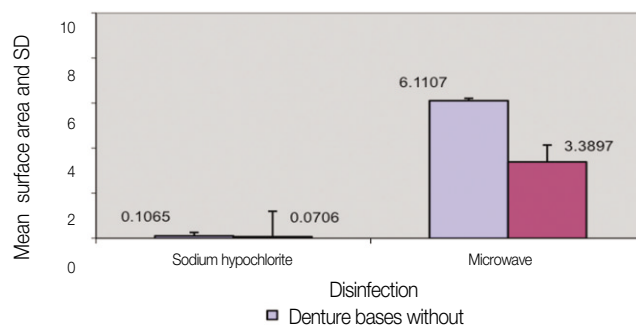
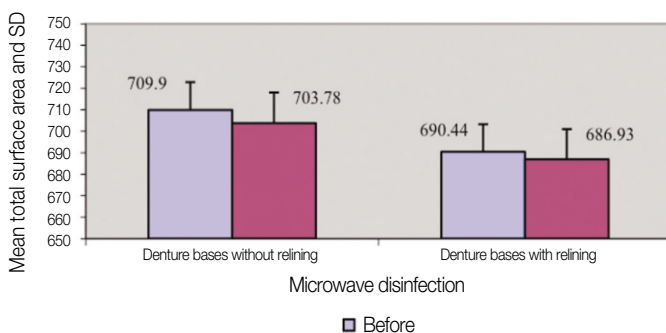
		Before disinfection*	After disinfection*	t	P
Sodium hypochlorite	Denture bases without relining	692.26 (13.74)	692.37 (13.72)	2.19	.056
	Denture bases with relining	694.38 (10.45)	694.41 (10.45)	2.17	.058
Microwave	Denture bases without relining	709.90 (12.96)	703.78 (12.82)	17.16	<.001
	Denture bases with relining	690.44 (14.24)	686.93 (14.06)	14.9	<.001

*All values in cells are Mean (SD), square millimeter.

Table 3. Comparison of dimensional stability of denture bases without and with relining after disinfection by sodium hypochlorite and microwave disinfection

	Denture bases without relining*	Denture bases with relining*	t	P
Sodium hypochlorite	0.1040 (0.1522)	0.0030 (0.0043)	1.479	.157
Microwave disinfection	6.1127 (1.1261)	3.5107 (0.7449)	6.094	<.001

*All values in cells are Mean (SD), square millimeter.

**Fig. 8.** Effect of sodium hypochlorite disinfection on dimensional stability of denture bases without and with relining.**Fig. 10.** Comparison of dimensional stability of denture bases without and with relining after disinfection by sodium hypochlorite and microwave disinfection.**Fig. 9.** Effect of microwave disinfection on dimensional stability of denture bases without and with relining.

DISCUSSION

The main results of this study showed that microwave disinfection produced significant changes in dimensional stability of denture bases without relining and denture bases with

relining when compared with sodium hypochlorite disinfection.

Microwave disinfection caused overall shrinkage of denture bases with and without relining which is suggestive of the structural changes that occurred inside the resin bases subjected to microwave irradiation protocol (650 W for 6 minutes). Previous study showed that the distortion of acrylic resins occurred when heated from 71 °C to 90 °C.¹⁷ Approximately after 90 seconds, water started to boil during microwave disinfection.¹⁴ This may cause diffusion of remaining residual monomer molecules in to the active sites of the polymer chain. Due to this, there might be further polymerization which lead to increase in linear dimensional change (shrinkage) of relined and without relined denture bases. The relined denture bases showed significantly less shrinkage compared with denture bases without relining. It might be due to the chemical composition of reline materials. This relined material contains 1, 6 hexanediol dimethacrylate, a cross-linking agent in higher percentage. The 1, 6 hexanediol dimethacrylate enhances a higher degree of conversion than the monofunctional monomers.⁷ Shrinkage in denture bases might be caused by release of inherent

stresses that were produced during polymerization. After relining, the magnitude of this effect was less, as denture base used for relining had reduced thickness. We used 650 W for 6 minutes for microwave disinfection as it was recommended as an effective method for disinfection of acrylic dentures along with the treatment of denture stomatitis and Candidiasis.¹⁴

Our results replicated the previous finding that the microwave disinfection significantly changes the dimensional stability of denture base resin.^{5,7,8} Microwave disinfection leads to linear dimensional alteration of complete dentures in horizontal and vertical directions. When compared differences in wattages i.e. 604 W for 6 minutes and 331 W for 6 minutes, reduced wattage causes less alteration in dimensional stability of acrylic resin.¹⁸ The microwave disinfection lead to significant alterations in the adaptation of maxillary acrylic resin denture bases to the stone casts at 604 W for 10 minutes, but 500 W for 3 minutes did not alter their fitting and stability.⁶ Thus, dimensional stability of acrylic resin denture bases after microwave disinfection depends on time of exposure and wattage used.

The results in this study are in disagreement with the findings of some of the previous studies that dimensional stability of acrylic resins was not affected by microwave disinfection. This might be due to the use of different materials and methods to measure distortion and irradiation protocols (power and time).⁹⁻¹²

The strength of this study was the specimens which were closely simulating clinical conditions. Asymmetric distortion might be caused due to the complex design of a denture bases. This might not be apparent if we only evaluate simple-shaped specimens. The limitation of this study was that this study evaluated the effect on only one denture base material and relined material. In addition, only one variety of microwave irradiation protocol and one type of concentration of sodium hypochlorite disinfectant were used for disinfecting the samples. Future studies are needed to evaluate the effect of various types of disinfection methods on different denture base and relined material with different concentration and disinfection protocols.

CONCLUSION

Within the scope and limitation of this study, it was concluded that the changes in dimensional stability of denture bases without relining and denture bases with relining were significant after microwave disinfection (650 W for 6 minutes) as compared to sodium hypochlorite disinfection (0.525% sodium hypochlorite for 10 minutes). Denture bases without relining showed more dimensional changes significantly than relined denture bases after microwave disinfection. Hence, chem-

ical disinfection seems to be a safer method of disinfecting dentures in comparison with microwave irradiation, as disinfection by microwave irradiation causes alteration with regards to physical properties such as changes in dimensional stability.

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