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COMPARATIVE STUDY OF DIMENSIONAL ACCURACY OF THREE CONVENTIONAL DENTURE BASE RESINS PROCESSED BY CONVENTIONAL METHOD AND MICROWAVE POLYMERIZATION.

[1]Naveen S Yadav

[1]Associate Professor, Department of Prosthodontics, Faculty of Dentistry, Garyunis University, Benghazi. Libya.

ABSTRACT

Statement of Problem: Poor adaptations of acrylic resin denture bases to the supporting tissues markedly decrease denture retention. Several denture base resin and processing techniques have been introduced to the profession, each claiming to produce a more accurate base. Microwave processing techniques has been introduced claims to minimize the dimensional changes. **Purpose:** The purpose of this study was to compare the dimensional accuracy of three denture base resins processed by conventional water bath method and by use of microwave energy. **Material and method:** Three Poly (MethylMethacrylate) heat cure resins were selected for this study.These resins were processed by (i) conventional water bath technique for 1.5 hours at 165^0F and half hour at 212^0F and (ii) microwave energy for 3 mins at 500W. A metal master die representing a maxillary arch with 4mm hole was prepared to evaluate the adaptation of the test resin denture base. A total number of 60 specimens were tested. The measurements of acrylic resin denture base specimens were compared with the measurements of master metal die dimension keeping it as a standard measurement. **Results:** The resin record bases processed by microwave curing method had slightly better dimensional accuracy than conventionally processed bases. There was no significant difference found in the dimensional accuracy when Resin record bases processed with a specially formulated resin for microwave curing was microwave cured and when conventionally available resins were processed by microwave technique. **Conclusion:** The resin record bases processed by microwave curing method had slightly better dimensional accuracy than the conventionally processed bases.

KEY WORDS: Microwave Processing, Dimensional Accuracy, Denture Base Resins.

INTRODUCTION

Poor adaptations of acrylic resin denture bases to the supporting tissues markedly decrease denture retention. These dimensional changes occur withprocessing technique. Different processing techniques like Conventional water bath technique, injection moulding and visible light cure technique[1] have been introduced each claiming to produce a more accurate base.

Microwave processing techniques had been introduced which claims to minimize the dimensional changes[2]. This study was undertaken to determine if there are significant differences in dimensional stability which could be attributed when three different denture base resins were processed by conventional water bath method and by use of microwave energy.

Materials and methods

Three Poly (MethylMethacrylate) heat cure resins selected for this study were Trevalon, Lucitone 199 and Acron MC. A metal master die was prepared to evaluate the adaptation of the test resin denture base. In order to standardize the die used for this study, certain preliminary measurements were taken at random from maxillary stone casts of the edentulous patients. The die was designed according to the mean values obtained form the stone casts, which resembled the shape of the maxillary edentulous area. A 4-mm drill was used to prepare reference indices in the metal die, on the ridge and on the palatal region. A total of 13 reference indices were prepared with depth of 8 mm. **(Fig.1)**. A mold was prepared using addition silicone duplicating material. The material was

mixed according to manufacturer's direction (1:1 ratio). Adequate amount of duplicating material was mixed and poured on the metal die in a specially prepared flask. Type III dental stone (Kalstone, kalabhai Pvt Ltd, Mumbai, India) was mixed according to manufacturer's direction (W/P ratio-30ml/100mg) 60 casts were prepared. To standardize the denture base for uniform thickness a permanent denture base was prepared by microwave curing at 500 w for 3 min. A uniform thickness of 1.5 mm was maintained. The permanent denture base was adapted on the stone cats and sealed using modeling wax. Then the processing was done by two techniques.

1. *Conventional water bath technique*: the casts were then invested using plaster of Paris in brass flasks. Standard water/powder ratio (45ml/100mg) as advocated by Phillips[1] was used and mixing was performed in vacuum mixer. The clamped flasks were then kept for 15 min. for the hemihydrate to set. Then the flask was opened and the permanent denture base removed. Then the molds were carefully cleaned with boiling water and dried in open air. Separating medium Sodium Alginate was applied into the mould cavity. The heat cure acrylic resin was mixed according to the manufacturer direction **(Table.1).**

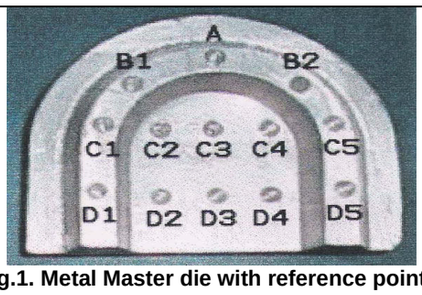

Fig.1. Metal Master die with reference points.

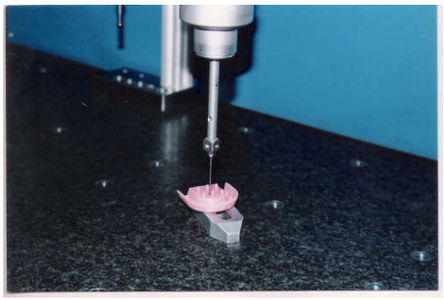

Fig.2. A computerized co-ordinate-measuring machine

Table. 1. Powder: Liquid ratio of heat cured resins.

Sl.No.	Material	Liquid powder ratio
1	Trevalon	4.2 ml of liquid to 10 gm of powder
2	Lucitone 199	4.7 ml of liquid to 10 gm of powder
3	Acron MC	4.3 ml of liquid to 10 gm of powder

The specimens were cured in recommended curing cycle, that is for 1.5 hours at 165^0F and half hour at 212^0F **(Table.2)**. After the polymerization the flasks were bench cooled for 1 hour. Then the flasks were carefully opened and the specimens were removed and necessary finishing was done.

2. *Microwave curing*: A specially made microwaveable flasks made-up of glass fiber-reinforced polyester resins, which are held together with bolts, were used. A 1:1 ratio of dental stone and plaster of Paris as recommended by the manufacturer were mixed with water (45ml/100mg) and poured into the flasks. Then the casts were invested into the flasks. After the flasks were bolted, it was kept for 15min, till the material was set. Then the flasks were opened and the denture base removed. The heat cure acrylic resin was mixed according to the manufacturer direction. When the material reached the dough stage, it was then pressed into the mould and a wet cellophane sheet was placed over it. The flask was closed carefully and the screws were tightened. 2-3 trial closures were done. Then the flasks were kept into the microwave oven for 3mins, at 500w. After the completion of curing cycle, the flask was removed from the oven and kept for beach cooling for 20 minutes. It was then removed and required finishing done. Immediately after finishing procedures, the five samples of each material were tested for linear changes.

A computerized co-ordinate-measuring machine was used to measure the distances between each point. This machine is capable of measuring the dentures in a three-dimensional relationship at any point in space or on the surface of the denture of any object to within micrometers. A contact probe is oriented in space by the three planes or axis **(Fig.2)**. The probe is interfaced with the computer

for measuring and recording the point location in the x, y and z-axes. Distances between each point were measured in master metal die and in acrylic denture base specimens. Totals of 18 measurements in each specimen were done.

The measurements of acrylic resin denture base specimens were compared with the measurements of master metal die dimension keeping it as a standard measurement. The mean values of the difference in the points compared were calculated, and compared to each other to determine if there was a statistically significant difference between them at the 0.05 probability level using the students' independent test for pooled variances. Comparisons were made of all the six groups of acrylic resin denture base samples.

Table.,2. Curing Cycle used for the heat cured resins.

Material	Curing Technique	Curing Cycle
Trevalon	Conventional	165^0F for 1.5 hours and 212^0F for half hour.
Trevalon	Microwave	500 W for 3 Minutes.
Lucitone 199	Conventional	165^0F for 1.5 hours and 212^0F for half hour.
Lucitone 199	Microwave	500 W for 3 Minutes.
Acron MC	Conventional	165^0F for 1.5 hours and 212^0F for half hour.
Acron MC	Microwave	500 W for 3 Minutes .

Results

Six sets of acrylic denture bases were tested for the linear changes.

Set A - Trevalon conventional cured
Set B- Trevalon microwave cured
Set C - Lucitone conventional cured
Set D - Lucitone microwave cured
Set E - Acron conventional cured
Set F - Acron microwave cured.

Each set consisted of 10 specimens. A total number of 60 specimens were tested.Each specimen had 13 Points. The distances between the points were measured. Table 3 shows the Mean (SD) for each material/technique combination. The P Value was < 0.05. No significant differences were found when three denture base resins were processed by conventional water bath technique and microwave technique.

Discussion

The close contact between the denture base and the cast results in better adaptation of the tissue surface of the denture to the oral tissues, and this close adaptation of the denture surface to the oral mucosa will result in a more retentive denture. Dimensional accuracy is therefore a desirable property of denture bases. Poly (Methyl Methacrylate) (PMMA) is the resin most commonly used fordenture bases. It has good esthetic properties, adequate strength, low watersorption, and low solubility. These bases are relatively more biocompatible, can be easily repaired, have the ability to reproduce the wax base fairly accurately, retain these details and dimension, and can be constructed by a simple molding and processing technique.

Several denture base materials and processing methods have been introduced to the profession, each claiming to produce a more accurate base. Microwave energy has been used for polymerizing acrylic resin. The microwave curing method has the advantage of saving time when microwave heating is used to polymerize denture base materials.[2,3]

De Clerck et al[4] and Takamata et al [5] have shown significant improvements in material manipulation, clinical use, and dimensional accuracy of this technique. The microwave generates heat within the resin. This results in a more rapid and even polymerization when the denture base is rotated on a carousel during microwave processing.

Bernard Levin[6] and Phillip Wallace [7] processed denture bases by conventional water bath technique and by microwave technique using long curing cycles. Their results showed no significant differences between denture bases cured by either method. In the present study, when processing was done using conventional water bath technique at 165° F for 1.5 hours followed by 212° F for half an hour and by microwave technique at 500W for 3 minutes, the results coincided with the results of Bernard Levin's and Phillip Wallace studies.

Table. 3. Mean (SD) for each material/technique combination

Sl No.	Points	Master Die Dimension	Trevalon		Lucitone		Acron MC	
			Conventional	Microwave	Conventional	Microwave	Conventional	Microwave
1.	AandB1	X 17.4089 Y 7.7046	X 17.4580 (0.06) Y 7.7579 (0.03)	X 17.4718(0.03) Y 7.7532(0.03)	X 17.4613(0.03) Y 7. 7996(0.01)	X 17.4585 (0.03) Y 7.7576(0.03)	X 17.4654 (0.02) Y 7.7578(0.03)	X 17.4134 (0.02) Y 7.7197(0.03)
2.	AandB2	X 17.2496 Y 7.0894	X 17.3320 (0.07) Y 6.9128(0.02)	X 17.2909(0.03) Y 7.0299(0.02)	X 17.2823 (0.01) Y 6.9643(0.03)	X 17.2822 (0.03) Y 7.0047(0.01)	X 17.3433 (0.02) Y 6.9905(0.07)	X 17.2842 (0.09) Y 6.9635(0.05)
3.	AandC3	Y 17.8105	Y 17.7521(0.03)	Y 17.7551(0.03)	Y 17.7792(0.01)	Y 17.7473(0.04)	Y 17.7524(0.03)	Y 17.7507(0.03)
4.	B1andC1	X 6.6048 Y 1 0.7234	X 6.6626 (0.02) Y 10.6780(0.02)	X 6.6686(0.03) Y 10.7017(0.01)	X 6.6294 (0.07) Y 10.6954(0.02)	X 6.6444 (0.02) Y 10.6650(0.03)	X 6.4860(0.01) Y 10.6900(0.02)	X 6.6202 (0.01) Y 10.695 7(0.09)
5.	B2andC5	X 6.2654 Y 10.8228	X 6.3119 (0.03) Y 10.8670 (0.02)	X 6.3 149(0.02) Y 10.8632(0.03)	X 6.3467 (0.02) Y 10.8632(0.01)	X 6.2931 (0.03) Y 10.8510(0.03)	X 6.3320 (0.02) Y 10.8891(0.04)	X 6. 3 187 (0.02) Y 10.8812(0.03)
6.	C1andD1	Y 17.7084	Y 17.7391(0.02)	Y 17.7616(0.03)	Y 17.7473(0.02)	Y 17.7456(0.03)	Y 17.7214(0.07)	Y 17.7225(0.01)
7.	C2andD2	Y 18.1698	Y 17.9833(0.03)	Y 18.0756(0.04)	Y 18.0792(0.05)	Y 18.0484(0.07)	Y 18.0426(0.05)	Y 18.0632(0.06)
8.	C3andD3	Y 18.3877	Y 18.2516(0.03)	Y 18.3188(0.03)	Y 18.3169(0.03)	Y 18.3116(0.07)	Y 18.3326(0.02)	Y 18.3624(0.02)
9.	C4andD4	Y 18.2552	Y 18.1583(0.03)	Y 18.2373(0.03)	Y 18.2122(0.01)	Y 18.2182(0.01)	Y 18.2184(0.01)	Y 18.2126(0.02)
10.	C5andD5	Y 17.7029	Y 17.7694(0.02)	Y 17.7602(0.02)	Y 17.7403(0.02)	Y 17.7266(0.02)	Y 17.7279(0.01)	Y 17.7601(0.02)
11.	C1andC2	X I1.8887	X 11.9215(0.02)	X 11.9545(0.04)	X 11.8973(0.06)	X I1.9478(0.06)	X I1.9228(0.06)	X 11.9097(0.05)
12.	C2andC3	X 12.0897	X 11.9944(0.05)	X 11.9737(0.09)	X 12.0651(0.04)	X 12.0066(0.05)	X I1.9269(0.01)	X 12.0309(0.04)
13.	C3andC4	X 10.9905	X 11.0746(0.06)	X 11.0665(0.07)	X 11.0859(0.06)	X I1.0991(0.06)	X I1.0301(0.05)	X I1.0599(0.07)
14.	C4andC5	X 12.5598	X 12.6129(0.01)	X 12.6091(0.03)	X 12.6364(0.02)	X 12.6114(0.03)	X I2.6411(0.07)	X 12,6177(0.02)
15.	D1andD2	X 13.8078	X 13.8842(0.04)	X 13.8613(0.03)	X 13.9249(0.05)	X 13.9169(0.03)	X 13.9013(0.01)	X 13.8342(0.02)
16.	D2andD3	X 11.3557	X 11.3013(0.02)	X 11.3058(0.03)	X 11.2901(0.04)	X 11.2449(0.03)	X 11.2779(0.01)	X 11.3168(0.02)
17.	D3andD4	X 11.8468	X 11.8754(0.01)	X 11.8743(0.02)	X 11.8808(0.02)	X 11.9074(0.02)	X 11.8914(0.02)	X I1.9109(0.01)
18.	D4andD5	X 13.8234	X 14.0091(0.05)	X 14.0166(0.06)	X 13.9553(0.02)	X 14.0120(0.02)	X 13.9005(0.01)	X 13.9887(0.01)

Takamata[5] compared five different techniques to process dentures and his results showed that the best fitting group was the microwave activated resin when cured for 3 minutes at 500W and the poorest fitting group was conventional water bath cured resin in which processing was done at 158^0F for 30 minutes and 212^0F for 30 minutes. When these results were compared to the results of the present study, in which there was no significant differences found in the denture bases cured by conventional water bath technique at 165° F for 1.5 hrs. and 212° F for half-hour and by microwave technique at 500 w for 3 min., it was found that the results were different from each other. This difference can be attributed to the time and temperature used to process a denture base in the studies of Takamata. Most of the studies[8-13] done on microwave processing was done with Acron MC denture base resin which is specially formulated for microwave technique. In this study both Acron MC and two commercially available denture base resins were processed by both microwave energy and conventional water bath technique. All denture base resins processed by microwave energy had slightly better dimensionally stability then resins processed by water bath technique.

CONCLUSION

In this study three-heat cure denture base resins were processed usingconventional water bath technique and microwave technique and compared for dimensional accuracy. The following conclusion was reached;

(i) The resin record bases processed by microwave curing method had no significant differences in dimensional accuracy when compaed to the conventionally processed bases.
(ii) There was no significant differences found in the dimensional accuracy when

- Resin record bases processed with a specially formulated resin for microwave curing was microwave cured and when conventionally available resins were processed by microwave technique.
- Resin record bases processed with a specially formulated resin for microwave curing was conventional water bath cured and when conventionally available resins were processed by conventional water bath technique.

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Corresponding Author

Dr.Naveen S Yadav
Associate Professor,
Department of Prosthodontics
Faculty of Dentistry
Garyunis University
Benghazi. Libya
Phone: 0021-892-266-0837
Email: naveensyadav@gmail.com