

Three dimensional changes in maxillary complete dentures immersed in water for seven days after polymerization

Shinsuke Sadamori¹, Toshiya Ishii¹, Taizo Hamada¹, and Arifzan Razak²

¹ Department of Prosthetic Dentistry, Graduate School of Biomedical Sciences, Hiroshima University, Hiroshima, Japan

² Department of Prosthodontics, The Faculty of Dentistry, Airlangga University, Surabaya, Indonesia

ABSTRACT

The purpose of this study was to investigate the three dimensional changes in the fitting surface and artificial teeth of maxillary complete dentures which were fabricated using two different polymerizing processes: heat polymerization (HP) and microwave polymerization (MP), after immersion in water for seven days. The amount of distortion in the molar region of the alveolar ridge was significantly different between HP and MP. However, the overall distortion of the dentures polymerized using both methods was similar. The distortion due to immersion in water for seven days compensated for the polymerization distortion, but the amount of distortion was very slight.

Key words: maxillary complete denture, three dimensional change after polymerization, microwave polymerizing

Correspondence: Dr Shinsuke Sadamori, Department of Prosthetic Dentistry, Graduate School of Biomedical Sciences, Hiroshima University, 1-2-3 Kasumi, Minami-ku, Hiroshima City, 734-8553, Japan, Tel: +81-82-257-5681, Fax: +81-82-257-5684, E-mail: tsada@hiroshima-u.ac.jp

INTRODUCTION

The provision of conventional complete dentures is the most realistic treatment for most edentulous older people, although other alternative treatments can be offered such as overdentures or implant retained dentures.¹

Generally, acrylic dentures should be washed in soap and warm water after polishing, and then stored in an antiseptic solution in a sealed polythene bag until supplied to the patient.² Acrylic polymers undergo dimensional changes that result in shrinkage and expansion,³ and are influenced by water uptake. Changes in linear dimension, warpage, and water uptake of acrylic resin denture bases are influenced by the processing method and the thickness.⁴ Overall dimensional denture base changes are the result of localized changes.

In the clinic, the storage of polished dentures in water before they are supplied to the patient would be at most around one week. In our previous study,⁵ we used a three-coordinate measuring machine to measure various distortions of denture specimens fabricated using two different polymerization processes. The aim of the present study was to measure and compare three dimensional changes in the fitting surface and artificial teeth of maxillary complete dentures fabricated with two different polymerization processes after immersion in water for seven days.

MATERIALS AND METHODS

Specimen preparation

Denture specimens were prepared according to the method used in our previous study.⁵ To fabricate the working cast, a die of an edentulous maxillary arch (402U, Nisshin, Kyoto, Japan) was duplicated using silicone elastomer (GC, Tokyo, Japan). A master cast was made of dental stone (New Fujirock, GC, Tokyo, Japan) according to the manufacturer's recommendation. The measuring points on the master cast consisted of 12 points on the alveolar ridge related to each second molar and first premolar tooth and the midway point of the incisor teeth, and on the denture flange in the molar, premolar and anterior regions. In addition, we set three datum-points (reference points) to set the coordinate system in the palate. The measuring points were set with steel balls with a diameter of 2 mm, and the datum-points were steel balls with a diameter of 4 mm set on the model using self-curing resin. The master cast was duplicated and six master casts were made. A wax denture was made on one of the six working casts. One thickness (approximately 1.5 mm) of base plate wax (paraffin wax, GC, Tokyo, Japan) was adapted to the working cast and the artificial teeth (GC Duradent: anterior teeth C3, posterior teeth 30M, GC, Tokyo, Japan) were positioned in the usual manner. The core of the wax denture was made with dental stone and silicon impression material. After the working casts were measured, three steel balls 4 mm in diameter

were set in the appointed positions as datum-points, and the wax dentures were made from the core. The measurement points were prepared on mesiolingual cusps of the right and left second molar tooth, the lingual cusps of the right and left first premolar tooth, and the mesial edge of the right incisor with a diamond point 1.8 mm in diameter (Diamond Point FG regular 340, Shofu, Kyoto, Japan).

Polymerizing process

Two acrylic resins were used: Bio resin (Shofu, Kyoto, Japan) and Acron MC (GC, Tokyo, Japan) (Table 1). The Bio resin was mixed using 4.5 ml liquid to 10 g powder. The polymerizing process followed Japan Industrial Standard's (JIS) recommendation: an initial 90 minutes at 70° C followed by 30 minutes at 100° C (HP). The Acron MC was mixed using 4.3 ml liquid to 10 g powder. Specimens (MP) were processed for 3 minutes in a 500 W microwave oven (EM-M 535 T, Sanyo Electric, Osaka, Japan). Ten standardized denture specimens were fabricated: five using the conventional technique and five using the microwave technique. After polymerization, flasks were allowed to cool at room temperature for over 12 hours and deflasked. Table 1 shows the polymerization process used.

Measuring method

Dimensional change was measured using a three-coordinate measuring machine (Tristation, TST 600-FC, Nikon Corp., Tokyo, Japan) graduated to an accuracy of 0.5 μ m or less at 20° C with a ball stylus measuring 0.5 mm in diameter.⁵ The measurements were performed on denture specimens after deflasking and immersion for seven days in water.

RESULTS

Figures 1, 2, and 3 show the dimensional changes after seven days immersion in water for both the fitting surface and the polishing surface. The cross point of the x and y axes of the reference plane is the center of the three reference points, and this point is the reference point for measurement in this study (Figure 1).

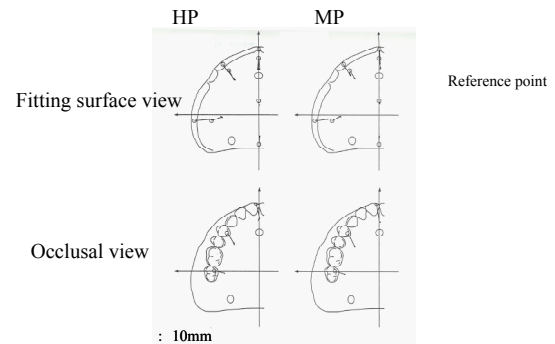


Figure 1. Dimensional change after immersion in water for seven days. The cross point of the axes indicates the center of the three reference points. Arrows indicate the direction of the change.

A line from the reference point shows distortion after deflasking. Another thick line shows distortion from the position of the reference point at deflasking to its position after immersion in water for seven days (Figure 2).

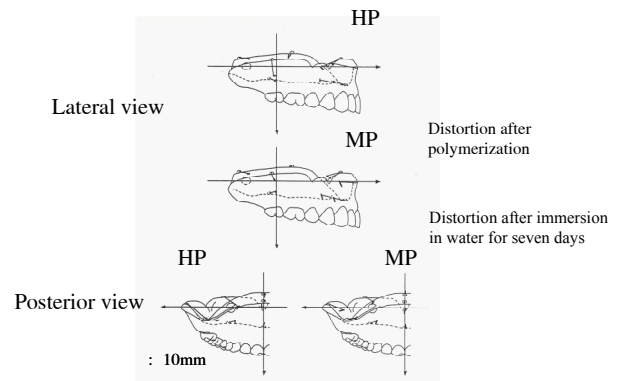


Figure 2. Dimensional change after immersion in water for seven days. The cross point of the axes indicates the center of the three reference points.

Distortion of the fitting surface

The distortion of the fitting surface in both HP and MP dentures was very small and occurred from the center of the denture to the outside in the horizontal plane (Figure 1).

Table 1. Materials and polymerization process used in this study

Processing method	Brand	Polymerizing cycle	Processing technique	Powder-to-liquid ratio (g/ml)	Manufacturer
Heat polymerizing (HP)	Bio resin	90 min at 70° C 30 min at 100° C	Hot water bath	10/4.5	Shofu Kyoto, Japan
Microwave polymerizing (MP)	Acron MC	3 min	Microwave 500 W	10/4.3	GC Tokyo, Japan

The distortion of the fitting surface in both HP and MP dentures occurred in a vertical direction to the occlusal plane (Figure 2). The amount of distortion of the reference point near the origin was less than for the distant reference point.

Distortion of the fitting surface of the alveolar ridge beyond the border of the palate occurred in a vertical direction towards the occlusal plane.

The distortion of HP dentures was similar to that of MP dentures. There was a significant difference in the amount of distortion in the molar region of the alveolar ridge between HP and MP (Figure 4).

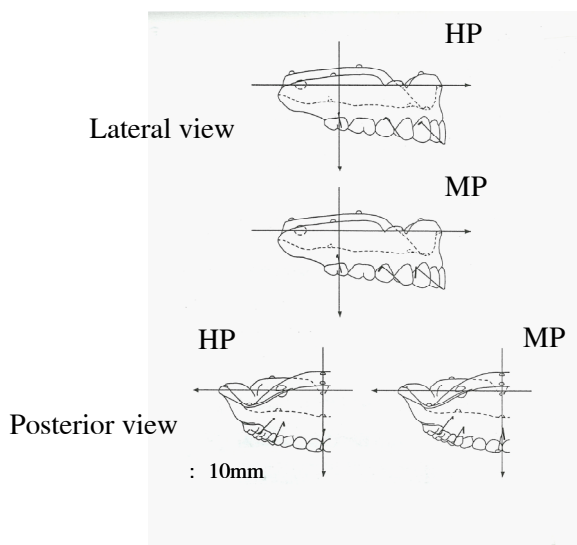


Figure 3. Dimensional change after immersion in water for seven days (artificial teeth). The cross point of the axes indicates the center of the three reference points.

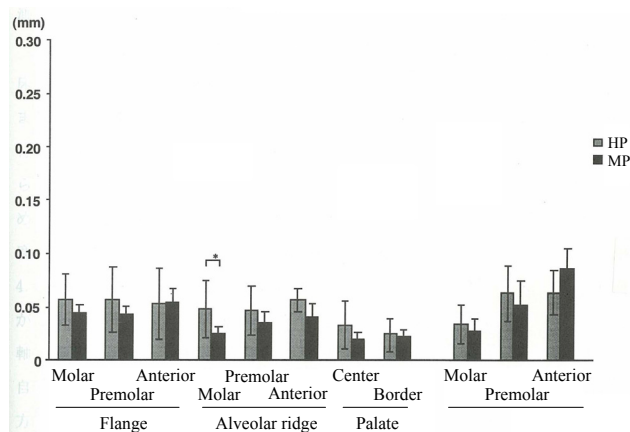


Figure 4. Amount of distortion.

Distortion of the artificial teeth

The horizontal distortion of the artificial teeth was similar to that on the fitting surface (Figure 1). The distortion of artificial teeth occurred in a vertical direction towards the occlusal plane, and the amount of distortion

of the reference points near the origin was less than for the distant reference points.

There was no significant difference in the amount of distortion between HP and MP dentures. The distortion of HP in a vertical direction tended to be larger than that of MP (Figure 3), and the distortion of MP in a horizontal direction tended to be larger than that of HP (Figure 1).

DISCUSSION

Our previous study⁴ indicated that the linear dimensional expansion and the amount of water sorption in thick resin specimens was greater than in thin samples. The linear dimension of each specimen tended to decrease after each day of storage in water. The linear dimensions of 1-mm HP specimens were similar from 1 day to 90 days in water. However, the 3-mm and 5-mm specimens increased in linear dimensions up until 60 days. The linear expansion and water sorption for specimens of the same thickness tended to be greater for microwave-activated resins than for heat-polymerized samples.

The flanges of denture specimens shifted towards the buccal side, and the alveolar ridge of the fitting surface shifted towards the occlusal plane. The artificial teeth shifted towards the origin. This distortion would be the result of the release of stress after deflasking.⁶

In the clinical situation, it is common for dentures to be immersed in water for up to seven days. The results of this study indicate that the distortion of maxillary complete dentures fabricated by both polymerization methods following immersion in water for seven days compensated for the distortion that occurred during the polymerization process. However the amount of the distortion was very slight. These results are consistent with Takahashi's results.⁷

The linear dimensions of each specimen (HP and MP) tended to decrease after one day of storage in water. This additional shrinkage may be due to the release of a considerable amount of elastic stress.⁶ However, the expansion of resin specimens after one week of storage in water varied. The 1-mm specimens had similar linear dimensions from 1 day to 90 days in water. However, the 3-mm and 5-mm specimens increased in linear dimensions up until 60 days.⁴ The overall dimensional changes in maxillary complete dentures are the result of localized changes. Dentists should therefore follow-up the condition of dentures until about 60 days after insertion into the mouth.

It concluded that the overall distortion of maxillary complete dentures polymerized by both methods was similar. The distortion caused by immersion in water for seven days compensated for the distortion that occurred during polymerization, but the amount of the distortion was very slight.

ACKNOWLEDGEMENT

This study was supported in part by a Grant-in-Aid for Scientific Research (16390617) from Japan Society for the Promotion of Science (JSPS).

REFERENCES

1. Anastassiadou V, Heath MB. The effect of denture quality attributes on satisfaction and eating difficulties. *Gerodontology* 2006; 23:23–32.
2. Bates JF, Huggett R, Stafford GD. **Removable denture construction**. 3rd ed. Butterworth-Heinemann LTD; 1991. p. 114–5.
3. Skinner EW, Cooper EN. Physical properties of denture resins, I: curing shrinkage and water sorption. *J Am Dent Assoc* 1943; 30:1845–52.
4. Sadamori S, Ishii T, Hamada T. Influence of thickness on the linear dimensional change, warpage, and water uptake of a denture base resin. *Int J Prosthodont* 1997; 10:35–43.
5. Sadamori S, Ishii T, Hamada T, Razak A. A comparison of three dimensional change in maxillary complete dentures between conventional heat polymerizing and microwave polymerizing techniques. *Dent J* 2007; 40:6–10.
6. Winkler S, Ortman HR, Morris HF, Plezia RA. Processing changes in complete dentures constructed from pour resins. *J Am Dent Assoc* 1971; 82:349–53.
7. Takahashi Y. Three dimensional changes of the denture base of the complete denture following polymerization. *J Jpn Prosthodont* 1990; 34:136–48.