A Study on the Accuracy of the record base of the Complete Denture to the Master Cast according to Kinds of Resin and Polymerization Method

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Statement of the problem. The record base in fabricating procedures of the complete denture, as a temporary form for reproducing denture base, is used to record upper and lower jaw relation and to align artificial teeth and try-in it in the mouth. The accuracy of jaw relation record is affected by the accuracy, stiffness and stability of the record base. So, the accuracy of record base is the most important requirements of jaw relation records.

Purpose of study. The purpose of this study was to evaluate the gap that occurred over the palatal area of a maxillary record base fabricated with autopolymerizing resin and light-curing resin.

Methods/material. The maxillary record bases were fabricated out of autopolymerizing resin that is used the most frequently in clinics and light-curing resin that attracts special attention for its several merits. The light-curing resin was made by two kinds of polymerization methods, which are one step curing method and multiple step curing method. All record bases were cut in certain positions of the master cast 1 hour and 1 day later after fabrication and the accuracy of the master cast was measured and analyzed with a microscope.

Results. A pattern of gap formation between the record base and the maxillary cast was observed in all specimens. According to kinds of resins, autopolymerizing resin was significantly more accurate than light-curing resin. There was no statistical difference according to time lapse, and in all three groups, the maximum discrepancy occurred at the posterior border in the mid-palatal region.

Concluslon. The autopolymerizing resin is better than light-curing resin, and multiple step curing method is more accurate than one step curing method when using light-curing resin.

The record base in fabricating procedures of the complete denture, as a temporary form for reproducing denture base, is used to record upper and lower jaw relation and to align artificial teeth and try-in it in the mouth[1]. The function of the record base is to record jaw relation for carrying occlusion rim, to maintain the artificial teeth on the wax rim during try-in, and to verify the accuracy of the recorded jaw relation[2]. Elder[3] mentioned accuracy and border form like as final denture base, strength against occlusion force, dimensional stability, easy fabrication, quickness and economical efficiency as the requirements for record base. Heartwell and Rahn[4] also said that the accuracy of jaw relation record is affected by the accuracy, stiffness and stability of the record

base. Therefore, the accuracy of the record base can be emphasized as one of the most important requirements that the record base should meet[5].

Among the various methods and materials for fabricating record base, there are two types which are commonly used. One is the temporary record base made out of autopolymerizing resin or light-curing resin and the other is the permanent record base made out of heat-curing resin, or noble metal, base metal[4,6]. When choosing record base material, price, strength, stability, easy fabrication method and colors should be considered. Recently the commonly used record base is the room temperature autopolymerizing resin, which has features of being thin but strong, fitted accurately and not easily changed.

Also the light-curing resin has attracted special attention recently as new record base material. After adaptation light-curing resin on the cast, the light-curing resin is made by polymerization it in the light curing unit. This method is easier and more economical because there is no need to mix powder and liquid. Also, it gives enough time for work, generates less setting heat and it is very easy to grind off the excessive resin around the border after polymerization.

For this study, the record base was fabricated out of autopolymerizing resin that is used the most frequently in clinics and light-curing resin that attracts special attention for its several merits. The light-curing resin was made by two kinds of polymerization methods, which are one step curing method and multiple step curing method. All record bases were cut in certain positions of the master cast 1 hour and 1 day later after fabrication and the accuracy of the master cast was measured and analyzed with a microscope. Some significant differences were observed and now I report the results of this study.

EXPERIMENTAL MATERIALS AND METHODS

Experimental materials and equipments

Materials and equipments used for this study are :

(1) Upper edentulous silicone mould
Upper edentulous master casts were made by pouring improved stone into silicone mould (Fig. 1).

(2) FujiRock® (GC Belgium, Belgium)

(3) Quicky® (NISSIN DENTAL PRODUCTS, Japan)
For autopolymerizing resin, powder and liquid were mixed (Fig. 2).

(4) Lightplast-Platten® (DREVE-DENTAMID GMBH, Germany)

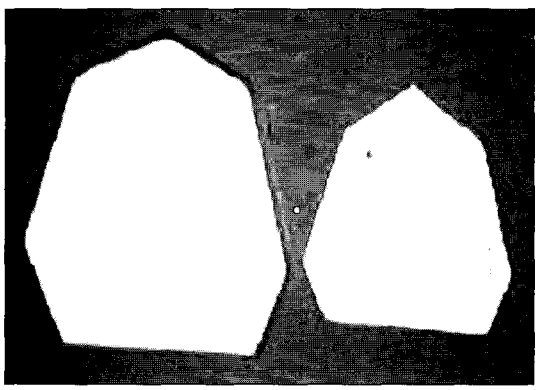

Fig. 1. Silicone mould and master cast.

Fig. 2. Quicky® self-curing resin (NISSIN DENTAL PRODUCTS, Japan).

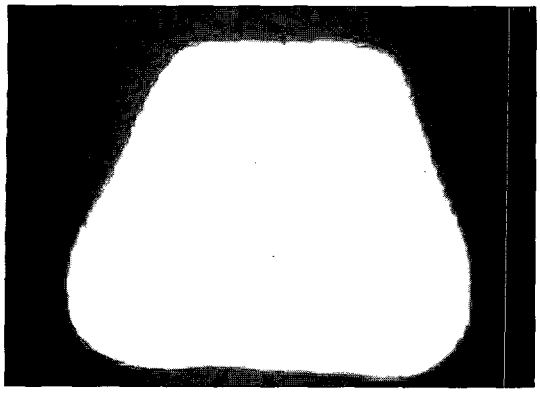

Fig. 3. Lightplast-Platten® light-curing resin (DREVE-DENTAMID GMBH, Germany).

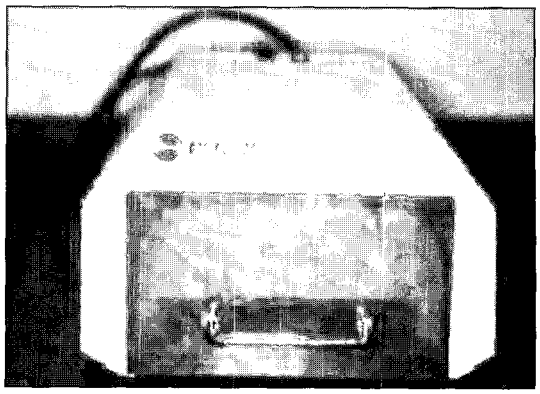

Fig. 4. POLYLUX-PT®(DREVE-DENTAMID GMBH, Germany) light curing unit.

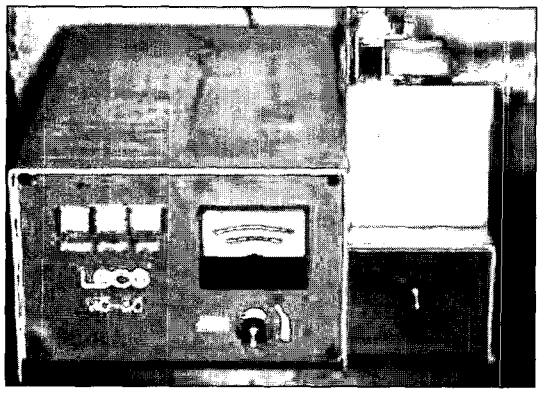

Fig. 5. VC-50 precision diamond saw®(LECO Co., U.S.A.).

For light-curing resin, this plate-shaped material was hardened in a light-curing unit (Fig. 3).

(5) Ostron mould® (GC Co., Japan)
It was used to make the constanst thickness of the resin 2mm.

(6) POLYLUX-PT® (DREVE-DENTAMID GM BH, Germany)
This light-curing unit, recommended by the Lightplast-Platten® manufacturer, was used for light-curing resin (Fig. 4).

(7) VC-50 precision diamond saw® (LECO Co., U.S.A.)
The master cast and the resin record base were cut in three positions of the posterior border, 15mm anterior and 30mm anterior using the saw (Fig. 5).

(8) Stereomicroscope SZ-ST® (Olympus, Japan)
The gap between the master cast and the record base was measured on each cutting planes with the rate of 40times (Fig. 9).

Experimental methods

(1) Fabricating the upper master cast
60 master casts were fabricated by mixing improved stone (FujiRock®, GC Belgium, Belgium) according to the directions of the manufacturer and pouring it into the upper edentulous silicone mould.

(2) Fabricating the record base
After applying lubricant on the cast, 20 record bases for each experimental groups were fabricated by using autopolymerizing and light-curing resin as follows.

① Group Ⅰ
Quicky®(NISSIN DENTAL PRODUCTS, Japan), autopolymerizing resin, was mixed according to the directions at the rate of 10g polymer and 5㎖ monomer, and formed in the constant thickness of 2mm in Ostron

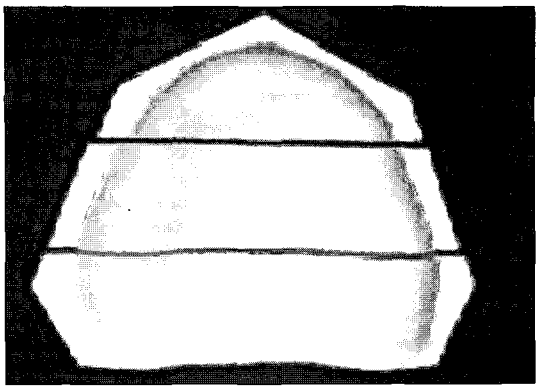

Fig. 6. Master cast sectioned three pieces.

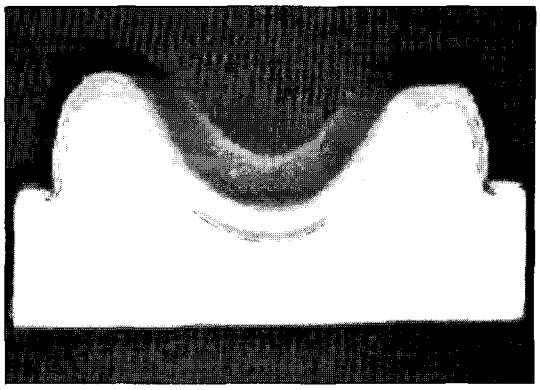

Fig. 7. Measuring points of master cast.

Table 1. Classification of experimental groups.

(Total : n=60)

	Group Ⅰ	Group Ⅱ	Group Ⅲ
	Quicky	Lightplast-Platten®(one-step curing)	Lightplast-Platten®(multi-step curing)
1 hour	n=10	n=10	n=10
1 day	n=10	n=10	n=10

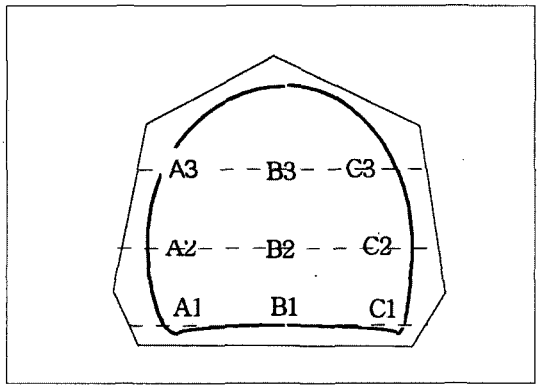

Fig. 8. Diagram of all measuring points.

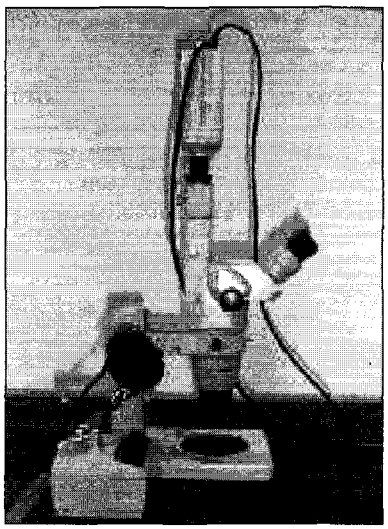

Fig. 9. Stereomicroscope SZ-ST®(Olympus, Japan).

mould®(GC Co., Japan), and then adapted on the cast. The materials were carefully adapted that it should not be thinned and air should not be included, and the excessive materials around the border were cut with a dental laboratory knife.

② Group Ⅱ

Lightplast-Platten®(DREVE-DENTAMID GMBH, Germany), light-curing resin, was adapted on the cast and the excessive materials around the border were cut with a dental laboratory knife. This was polymerized for 5 minutes according to the directions of the manufacturer in POLY-LUX-PT®(DREVE-DENTAMID GMBH, Germany) curing unit and the inside of it

was polymerized for 3 minutes afters eparating the record base from the master cast.

③ Group Ⅲ

Lightplast-Platten®, light-curing resin, was adapted on the cast and the excessive materials around the border were cut. After the palatal area inside the alveolar crest was covered to the bottom of the cast with aluminum foil lest the light should pass through it, the resin was polymerized in POLYLUX-PT® for 1.5 minutes. The aluminum foil around the palatal area was eliminated and unpolymerized resin was readapted on the cast. The second aluminum foil of the size as half as the first one was adapted on the palate and then polymerized for 1.5 minutes. The aluminum foil was eliminated and unpolymerized resin was readapted on the cast, and then polymerized for 2 minutes. The record base was separated from the cast and the inside was polymerized again for 3 minutes.

The gap between the record base and the cast was measured 1 hour later for one half (10 record bases) and 1 day later for the other half (10 record bases) of each group. Table 1 shows the classification of the experimental groups according to resin types, fabrication methods and polymerizing time.

(3) Cutting of master cast and record base

The master cast and the record base were cut in 2 positions of 15mm anterior and 30mm anterior from the posterior border using VC-50 precision diamond saw (LECO Co., USA), a low-speed rotary saw®(Fig. 6). On the posterior border, 15mm anterior and 30mm anterior cutting planes, left alveolar crest, midpalate, and right alveolar crest were marked as the measuring points of A, B, C.(Fig. 7). Fig. 8 shows the locations of all measuring points.

(4) Measuring the accuracy

The gap between the master cast and the record base was measured on each measuring point with the rate of 40 times using Stereomicroscope SZ-ST®(Olympus, Japan), which is three-dimensional, light microscope.

(5) Statistics

SPSS V8.0 for win(SPSS Inc., USA) was used for the statistical procedure of the study results, and the statistics was verified to 95% of significant standard using one-way ANOVA test and independent t-test.

EXPERIMENTAL RESULTS

The mean and standard deviation of all experimental groups

Point C3 of the Group Ⅰ measured 1 day later showed the highest accuracy (31.30±5.78 ㎛), and point B1 of the Group Ⅱ measured 1 hour later showed the lowest accuracy (642.30±62.58 ㎛). Table 2 shows the mean and standard deviation of all experimental groups.

The accuracy according to kinds of resins

The mean of the gaps between autopolymerizing resin and the master cast was 127.76±85.99㎛ and for the light-curing resin it was 243.36±176.23 ㎛. The independent t-test of the accuracy according to kinds of resins showed that the autopolymerizing resin was significantly more accurate than light-curing resin($p<0.05$) (Table 3, Fig. 10).

The accuracy according to polymerizing method of light-curing resin

Of light-curing resin, the mean of Group Ⅱ was 293.97±215.50㎛ and Group Ⅲ was 192.43±150.70㎛. The results of independent t-test for the accuracy according to polymerizing method of light-curing resin showed that multiple step curing method(Group Ⅲ) was significantly more

Table 2. Mean and standard deviation of experimental groups. (unit : ㎛)

	Group Ⅰ		Group Ⅱ		Group Ⅲ	
	1 hour	1 day	1 hour	1 day	1 hour	1 day
A1	38.97 ±3.48	33.84 ±9.47	231.82 ±14.14	164.90 ±46.73	180.41 ±50.28	112.75 ±13.43
B1	239.93 ±30.86	219.62 ±27.30	642.30 ±62.58	618.15 ±27.74	441.19 ±24.44	376.07 ±43.98
C1	44.62 ±4.47	40.84 ±5.84	189.95 ±18.80	168.63 ±16.92	210.57 ±42.11	116.96 ±17.51
A2	45.50 ±3.87	45.23 ±3.24	134.26 ±19.10	155.69 ±20.96	103.36 ±21.77	84.53 ±17.68
B2	228.17 ±41.58	202.75 ±36.88	578.32 ±34.25	522.50 ±48.90	267.13 ±49.45	213.89 ±26.71
C2	43.50 ±5.01	40.78 ±5.55	132.72 ±25.04	145.94 ±21.57	98.26 ±24.18	93.00 ±27.65
A3	37.02 ±2.26	36.89 ±5.49	112.45 ±33.60	135.68 ±21.42	46.44 ±5.28	53.99 ±8.34
B3	194.54 ±19.95	214.04 ±30.16	320.10 ±44.48	362.50 ±35.00	208.17 ±24.17	146.89 ±39.95
C3	32.14 ±5.12	31.30 ±5.78	132.92 ±32.40	138.08 ±19.53	44.53 ±3.54	65.15 ±7.43

Table 3. Mean, standard deviation and significance of independent t-test for accuracy according to experimented resins. (unit : ㎛)

Resin	N	Mean	S.D.	Sig.
Group Ⅰ	180	127.76	85.99	
Group Ⅱ + Ⅲ	360	243.36	176.23	.000

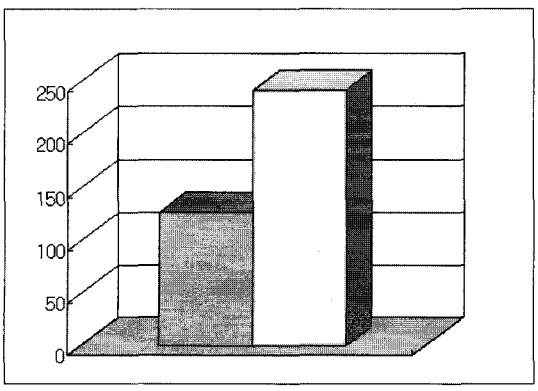

Fig. 10. The mean value of Group Ⅰ and Group Ⅱ + Ⅲ

accurate than one step curing method(Group Ⅱ) ($p<0.05$) (Table 4, Fig. 11).

The accuracy according to time lapse after fabricating record base

The mean of the gaps was 192.58±178.00㎛ 1 day later after fabricating record base and 216.86 ±179.24㎛ 1 hour later. The results of independent t-test for the accuracy according to time lapse after fabricating record base showed there was no statistical difference according to time lapse (Table 5, Fig. 12).

The accuracy according to positions

The results of one-way ANOVA test and multiple range test for accuracy according to positions showed significantly less accuracy in the midpalatal region (B) than the left and right alveolar crest region (A, C), and no statistical difference between

Table 4. Mean, standard deviation and significance of independent t-test for accuracy according to polymerizing method of light-curing resins. (unit : ㎛)

Polymerizing method	N	Mean	S.D.	Sig.
Group Ⅱ	180	293.97	215.50	.000
Group Ⅲ	180	192.43	150.70	

Table 5. Mean, standard deviation and significance of independent t-test for accuracy according to time. (unit : ㎛)

Time	N	Mean	S.D.	Sig.
1 hour	270	192.58	178.00	.485
1 hour	270	216.86	179.24	

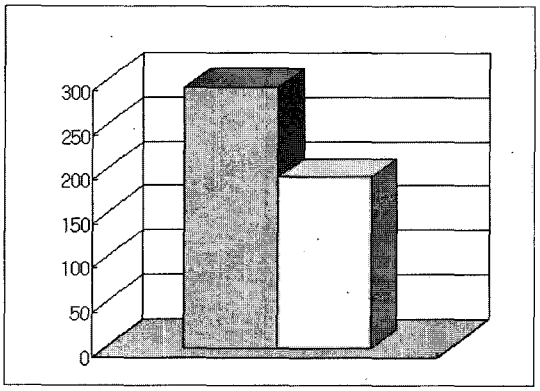

Fig. 11. The mean value of Group Ⅱ and Group Ⅲ.

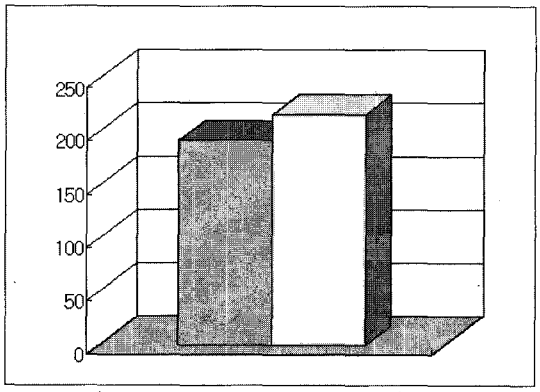

Fig. 12. The mean value of 1 day and 1 hour.

A and C. In all three groups, the maximum discrepancy occurred at the posterior border in the midpalatal region (B1) ($p<0.05$) (Table 6, 7).

DISCUSSION

The maxillo-mandibular jaw relation record using record base is the most difficult procedure during which dentists make more errors than any other steps in fabricating complete dentures. It is partly because they haven' t realized that the fabricating record base is so important. The accuracy and strength of record base decides the accuracy of jaw relation record.

The function of record base from diagnostic views is to check previously the border length resulted from the final impression, the accuracy of the denture base and the possible adjustability related to the final denture base. From the therapeutical views, the record base is needed to acquire determination of vertical dimension of occlusion, decision of centric relation record, transferring of accurate jaw relation to articulator, and the proper alignment of artificial teeth for trial denture base. Therefore fabrication the record base[7] would be the most important procedure in dental techniques and clinics as well.

Hence the record base should be fabricated in order to be accurately fitted and it should not be changed but remain stable. Even the inaccurate record bases can look well fitted in the palate because of elasticity of soft tissue, but it doesn' t mean that it fits accurately in reality. The inaccurate record base incurs errors in the final occlusion of complete denture due to the inaccurate jaw relation record[8,9].

For record base material, temporary record bases are made out of shellac, baseplatewax, autopolymerizing resin, light-curing resin and vacuum-adapted resin. Permanent record base are made out of heat-curing resin and metal[10].

Table 6. Results of one-way ANOVA test for accuracy according to position.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11323371.5	8	1415421.43	128.605	.000
Within Groups	5844143.85	531	11005.921		
Total	17167515.3	539			

Table 7. Results of multiple range test for accuracy according to position.

	A1	B1	C1	A2	B2	C2	A3	B3	C3
A1									
B1	*								
C1		*							
A2		*							
B2	*	*	*	*					
C2		*			*				
A3		*			*				
B3	*	*	*	*		*	*		
C3		*			*			*	

* Denotes pairs of groups significantly different at the 0.05 level.

The commonly used record base material in clinics is autopolymerizing acrylic resin. This type of resin doesn't need outside heat but it needs activator and catalyst for polymer. Among the 3 fabrication methods, the sprinkle-on method is by spreading powder and liquid alternately. The finger-adapted dough method is by mixing powder and liquid according to the directions of the manufacturer to get viscosity of dough and then adapting it on the master cast with fingers. The confined-dough method is by polymerizing under pressure in a flask[11,12] like as heat-curing resin. Autopolymerinzing resin costs less, is hardened firmly and easy to fabricate. In addition to that, it is so strong, stable, accurate and hardly changed that is suitable for jaw relation record. It has been reported that autopolymerizing resin is more accurate than heat-curing resin[13,14]. But it occupies the space for arranging teeth so some trimming is needed and the undercut relief of the master cast can make it less accurate[15], and also the monomer of the resin gives harmful effect on people who handle it. Because of these disadvantages, people have looked for material which is safer, more economical and easier to make[16]. To meet this demand, the light-curing resin, which can be used more conveniently than autopolymerizing resin, has been newly introduced.

The light-curing resin is composed of urethane dimethacrylate matrix and a small amount of silica which adjusts flow[17,18]. There is no need to mix powder and liquid, therefore it gives no harm on human bodies due to inhaling poisonous smell and powder. Also it can be dealt with hands harmlessly because it needs no liquid. It is easy to make and economical due to less waste of material[19]. It is not polymerized until light-curing so it secures enough time for work and produces less setting [illegible] But it has its disadvantages that it needs a special light-curing unit and occurs setting contraction.

In this study, record bases were made out of the commonly used autopolymerizing resin and light-curing resin to measure the accuracy of the record base to the master cast. A pattern of gap formation between the master cast and the record base was observed in all experimental groups. According to kinds of resins, autopolymerizing resin was significantly more accurate than light-curing resin.

Many studies on the stability of resin has been made for so long. For autopolymerizing resin, there have been introduced to the market various kinds of products, but most of them are reported no dimensional changes after 9 hours[21-23]. But light-curing resin acquires dimensional stability right after polymerization only if it is complete-

ly polymerized with proper light source and exposure time[24], and can be used right away, which is believed to be clinically useful. However, another study on the light-curing resin[25] showed that exposed to polymerizing light, the closest material would be polymerized first, which causes the formation of gap due to transformation and contraction. The reason of such formation of gap with the master cast is the contraction because of polymerization and cooling[26], and being lifted by internal stress during polymerization[27]. A part of the internal stress is alleviated through the flow of resin material. So although polymerizing contraction occurs to autopolymerizing resin[28,29], the gap can be minimized by manufacturing the resin continuously on the cast until the final polymerization. But for the light-curing resin, the first polymerized surface directly receiving light limits the flow of material[22,30,31], which makes it impossible to adapt it continuously on the cast with fingers[3] to prevent the resin from being lifted until the final polymerization like autopolymerizing resin and as the result, it shows low accuracy. I conjectured that it would be possible to minimize the gap formation resulted from polymerization transformation by limiting the amount of material exposed to light at a time when using light-curing resin. So for this study, Group Ⅱ was polymerized at once according to the directions of the manufacturer, and Group Ⅲ was polymerized in multiple steps by separating the palatal region. In the comparison of polymerizing method of light-curing resin, multiple step curing (Group Ⅲ) method was significantly more accurate. We can infer from this result that fabrication method is very important when using light-curing resin. In all three groups for this study, the maximum discrepancy occurred on B point at the posterior border of the record base in Group Ⅱ, which was fabricated by exposing the whole material to the light according to the directions of the manufacturer. According to the study by Elahi and Abdullah[29], the average change of size at the posterior border of the maxillary record base fabricated by 5 kinds of polymerization methods using autopolymerizing resin was 203~293㎛, and the record base with such change of size could be made up for through the elasticity of its pressed tissue. But when light-curing resin is polymerized at once like Group Ⅱ, it cannot be made up for through the elasticity of its pressed tissue because gap size was large. Therefore it is recommended that the accuracy of the light-curing resin should be improved through multiple step curing method like Group Ⅲ when using light-curing resin.

Skinner[32], reported that resin was not contracted by the same amount in all directions during polymerization, and Shaaban[33]and Chen[34] reported that the posterior of palate showed the maximum discrepancy. Also some study reported that the accuracy of the record base in the same cast could be different according to the cutting planes, and it could be different according to the positions even on the same cutting plane[35]. In comparison of accuracy according to the positions, the midpalatal region showed less accuracy than left and right alveolar crest in all three groups of this study[28], and the maximum discrepancy occurred on point B at the posterior border. So a proper method of sealing posterior palatal border should be used.

Therefore it is recommended that autopolymerizing resin should be used because it is more accurate when fabricating the resin record base of the complete denture, and when using light-curing resin for its advantages which is easy to make and possible to use right after fabrication, the multiple step light-curing method should be used like in this study.

CONCLUSION

For this study, the resin record base was fabricated with autopolymerizing resin, Quicky®, and light-curing resin, Lightplast-Platten®, divid-

ed into three experimental groups according to the kinds of resin and the polymerization methods of light-curing resin. These master casts and record bases were cut in three positions with a low speed rotary saw 1 hour and 1 day later respectively and then the gap was measured by a stereomicroscope.

The results were as follows:

1. A pattern of gap formation between the record base and the maxillary cast was observed in all specimens. According to kinds of resins, autopolymerizing resin was significantly more accurate than light-curing resin ($p<0.05$).
2. In the comparison of polymerization method of light-curing resin, multiple step curing (Group Ⅲ) method was significantly more accurate than one step curing method (Group Ⅱ) ($p<0.05$).
3. In the comparison according to time lapse, there was no statistical difference of accuracy between the two groups of 1 hour lapse and 1 day lapse in all three groups.
4. In all groups, the maximum discrepancy occurred on point B at the posterior border, which showed statistical difference from other positions ($p<0.05$).

From the results as above it can be concluded that autopolymerizing resin is better than light-curing resin, and multiple step curing method is more accurate than one step curing method when using light-curing resin.

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