



Influence of Heating Rates and Residual Monomer on Dimensional Changes of Acrylic Resin Denture Base

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Abstract

Background: Most of spaces between the denture base and master cast produced by shrinkage of the base material during polymerization and by the difference in coefficient of thermal expansion of the cast and acrylic resin. The aim of this study is to evaluate the effect of the different heating rates and the presence of residual monomer on the accuracy different curing denture base by recording the gap space between the cast and the denture

Materials and methods: 18 maxillary edentulous stone cast were prepared then divided into three main groups, denture bases were constructed. In Group A, using Biostar plates (free of monomer) in the pressure chambers. In group B, using short curing cycle while group C, using long curing cycle . The gap space between the cast and denture base was recorded using traveling microscope measuring device.

Results: Biostar curing resin (group A) showed significantly the highest dimensional changes among groups (short and long curing resins). There was no significant difference between group B (short curing resin) and group C (long curing resin). The lowest gap space values were obtained in long curing resin. All samples showed maximum discrepancy in mid palatal region and minimum dimensional changes at the crest of ridge. Minimum gap space values were shown in the canine region for record bases cured with short and long curing cycles, while minimum gap space values were shown in the posterior palatal seal for record base cured with Biostar machine.

Conclusion: The dimensional changes of record bases mainly depend on the amount of heat applied during processing rather than the amount of residual monomer. Greater distortion was shown in record base processed by Biostar machine (Free of monomer), while the least distortion in record base processed by long curing cycle. All samples showed maximum discrepancy in the mid palatal region and minimum dimensional changes at the crest of ridge.

Keywords: Heat cure acrylic resin, Biostar sheet plates, residual monomer.

Introduction

Dimensional stability of the denture during processing and in service is important in the fit of the denture and satisfaction of the patient . In general if the denture is properly processed the original fit and dimensional stability of

various denture base plastic is good.^(1, 2)

Consani et al ⁽³⁾ Concluded that the most significant linear shrinkage usually occurs in the posterior palatal region of the maxillary denture, resulting in a gap between the palatal

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zone and the processed denture, therefore, Sykora & Sutow^(4,5) used a high expansion stone to compensate the shrinkage, that occurred as a result of the processing of acrylic resin, and found that the use of this material reduced the size of the posterior palatal border of the maxillary denture at least 50%. The amount of residual monomer is one of the principal factors that affects the properties of acrylic resin denture base.⁽⁶⁾ The amount of monomer used must be kept as low as possible, but it must be sufficient to have two important effects. First, it must often the hard polymer grains and so reduce the molding pressure. Secondly, There must be sufficient monomer to glue the polymer particles together in the solid mass.^(7,8)

The choice of curing cycle had greater influence on dimensional accuracy of PMMA, specially curing cycle includes long terminal boiling period shows significantly better physical and mechanical properties.⁽⁹⁾ Huggett et al.⁽¹⁰⁾ Suggested that 7 hours at 70°C followed by 3 hours at 100°C achieved minimal level of residual monomer. Bartoloni et al,⁽¹¹⁾ showed that residual monomer did not vary considerably under different curing conditions, as compared to findings by McCab Basker⁽¹²⁾ the shorter curing cycles did not significantly affect the final degree of conversion.

The residual monomer level decreased for longer curing times of heat cured samples, The lowest residual monomer content was obtained by a long –term terminal boiling and then stored in the distilled water for at least one day.⁽¹³⁾

Materials and Methods

Heat cure acrylic resin "Stellor QC-20" Densply Iso 1567 type 1 class I ADA No. 12 and Biostar plates (free of

monomer) Imprelon hard blank were prepared. Thickness of all denture base samples is 3mm, type III model dental stone / Elite model Thixotropic (Zhermack)_ Italy, dental wax (cavex set up regular wax)_ Holland , separating medium (cold mould seal) ,Kemdent_UK.

Standardized rubber mould with medium palatal depth (New York) was used, mixing stone ratio of 22-23ml of water to 100gm of powder, according to the manufacturer instructions. The mixed stone was poured slowly in to the mould with good vibration to prevent entrapment of air. The stone is allowed to harden for 60 minute. Then the cast was separated from the mould. Samples Grouping: They were divided into three main groups:

For group A, the record base was prepared using Biostar machine by placing the cast on the table of machine and the plate in the pressure chamber, the plate was softened and pressed on the cast, the cast with plate was removal then trimming and finishing was done by biostar burs.

For group B,C, the mixing of acrylic powder / liquid ratio was 3:1 by volume, the polymerization made in thermostatically controlled water bath for two different curing cycles :

1-Short curing cycle- the flask was immersed in water then brought to 74°C for 1.5 hour; the temperature was raised to 100°C for additional 30 minutes.

2- Long curing cycle- the temperature was raised to 74°C and maintained for more than 8hours (over night). Then trimming and finishing was done.

The base- casts were transversally sectioned into three parts corresponding to the zones: distal to the canine, mesial to the first molar and at posterior palatal seal area.⁽¹⁴⁾ Base cast was positional in the sawing device under constant water cooling.

The Three points were marked on each section ((Left ridge crest, midline, right ridge crest as in figure {1,2}. Denture base and stone cast sections were kept in the incubator under controlled conditions, such as temperature at 20 ± 1 °C, and relative humidity at 50 ± 5 %, ⁽¹⁵⁾ until the measurements were made with a traveling microscope capable of measuring up to 0.001mm. ⁽¹⁶⁾

Results

- In canine region: higher values of gap space were obtained in Biostar curing resin and lower values showed in long curing cycle resin as in table 1, the Biostar curing resin showed very high significant difference than short and long curing resins as in table 2.
- In molar region: higher dimensional changes values were obtained in Biostar curing resin and lower values obtained in long cycle curing as in table 1, the Biostar curing resin showed high significance with long curing cycle, while there were non significant difference between short and long curing cycles as in table 2.
- In posterior region : higher discrepancy were showed in Biostar curing resin and lower values were obtained in short curing cycle as in table 1, the long curing cycle resin showed non significant difference with Biostar and short curing resins, while there were a significant difference between Biostar and short curing resins as in table 2.
- In table 3: The LSD test between tested groups were showed highly significant difference ($p < 0.01$) between the Biostar curing plates and the short, long curing cycles, while there is a non significant difference ($p > 0.05$) between short and long curing cycles.
- The mean values of gap space that obtained in acrylic resin processed by Biostar machine were significantly higher than that processed by short and long curing cycles. This is due to high and rapid temperature (80°C) applied during processing with in few seconds without press; also there was close correlation between the degree of shrinkage and the amount of heat applied during processing.
- Although, the gap space of denture bases cured by short curing cycle higher than that cured by long curing cycle but its statistically not significant this is due to the higher level of residual monomer in short curing cycle as well as the material in short curing cycle was exposed to heat at 100°C which result in increased internal stresses and dimensional inaccuracy. The result of this study in agreement with that of Huggett et al 1984 ⁽¹⁰⁾, and Dogan et al 1995. ⁽¹³⁾
- There was no significant difference observed between point (a) and point (c) { crest of the ridge (left & right) }, while significant difference was observed between points (a,c) and point (b), this mean that the gap space in the mid palatal region significantly higher than at the crest of ridge, this is due to The pressure application and heat of polymerization process was transfer from the highest area to the midline area according to the creep phenomenon, in addition to the volume of acrylic resin was more in the midline area, so greater volumetric shrinkage and more internal stress release was occurred which lead to high gap space, this agree with Chen et al 1988. ⁽¹⁷⁾
- The gap space values in the posterior palatal seal significantly higher than canine region in short and long curing cycle this due to the

Discussion

topographic from the anterior arch limit the stress released after mould separation, while the posterior palatal region was less restrictive and permits strain release producing more distortion, this agree with Consani et al 2002⁽³⁾

Conclusions

- 1- The dimensional changes of record base not mainly depend on the amount of residual monomer but also depend on the amount of heat applied during processing.
- 2- Greater distortion was shown in record base processed by Biostar machine (Free of monomer), while less in short curing cycle and lesser distortion in record base processed by long curing cycle.
- 3- Maximum discrepancy in the mid palatal region and minimum dimensional changes at the crest of ridge for all samples.
- 4- Minimum gap-space values were shown in the canine region for record bases cured with short and long curing cycle. while Minimum gap- space values were shown in the posterior palatal seal area for record bases cured with Biostar machine.

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Table (1): Mean gap-space analysis of three groups in three regions.

Canine region				Molar region				Posterior region			
Groups	No.	mean	SD	Groups	No.	mean	SD	Groups	No.	mean	SD
Group A	18	0.74	0.39	GroupA	18	0.52	0.33	GroupA	18	0.27	0.15
Group B	18	0.08	0.11	GroupB	18	0.22	0.38	GroupB	18	0.06	0.09
Group C	18	0.05	0.04	GroupC	18	0.12	0.08	GroupC	18	0.19	0.43

Table (2): LSD comparison between three groups in three regions.

Regions	Group A	Group B	Group C
Canine	V.H.S	←→	←→
		←→	←→
Molar	H.S	←→	←→
		←→	←→
Posterior	S	←→	←→
		←→	←→

Table (3): Mean gap-space analysis and LSD comparison between three groups.

Comparison groups	No.	Mean	SD
Group A	54	0.513	0.361
Group B	54	0.126	0.246
Group C	54	0.121	0.258

Group A	Group B	Group C
V.H.S	N.S	
	V.H.S	

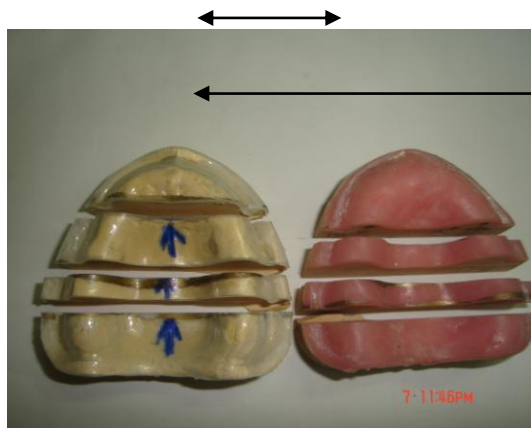


Fig (1): base cast sections

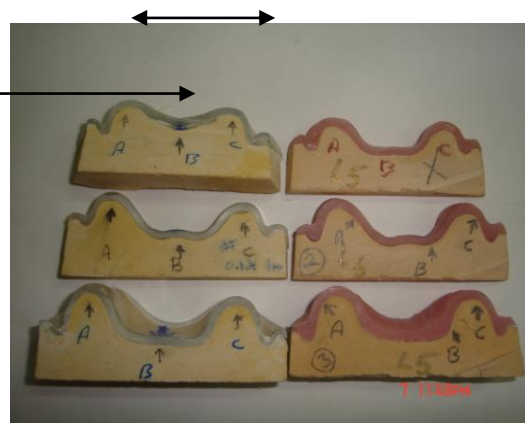


Fig (2): Transverse sections