

The Effect Of Different Curing Times on The Hardness, Fracture Resistance And Color Change of Visible Light Cured Denture Base Resin

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ABSTRACT

Aim: To evaluate the effect of the organic acid solution on color stability of the facing heat-cured acrylic resin. **Materials and methods:** Two heat-cured facing acrylic resins were used in this study. Sixty four rectangular shape specimens were prepared to evaluate the color changes of the heat-cured acrylic resin after immersion in three organic acids (acetic, citric and lactic acids). The specimens were divided into two groups according to tested resin materials, and then subdivided into four tested groups according to immersion solution, eight specimens for each subgroup. The assessment of color property (opacity) done by using ultra-violet visible spectrophotometer at wavelength 345 nm. Mean values were compared statistically with one way analysis of variance (ANOVA) followed by Duncan's multiple range test to determine the significant difference among the tested groups at ($p < 0.05$) level of significance. **Results:** The results showed that there is a significant difference of the means value of the color change among the four tested groups for both tested materials for two different immersion periods, but there is no significant difference of color change between tested materials. Specimens immersed in acetic acid have a higher value than that immersed in other organic acids. **Conclusion:** The result of this study show that immersion in organic acids for different immersion periods had a significant effect on color stability of the facing heat-cured acrylic resin cured acrylic resin.

Key words : color change , heat-cured acrylic resin, organic acids

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INTRODUCTION

Visible light-cured (VLC) denture base are the materials of choice for a wide range of clinical applications, such as repair materials, complete-denture construction, patient with hyper sensitive to poly methayl methacrylate, and obturator materials. This materials exhibit superior handling characteristics compared to chemically-cured materials.⁽¹⁻⁴⁾

Visible light-cured (VLC) denture base consists of a urethane dimethacrylate matrix with an acrylic copolymer, micro-fine silica fillers, and a photoinitiator system. The VLC denture base is polymerized in a light chamber with blue light of 400 to 500 nm.⁽⁵⁾ A visible light source is employed to produce the work that converts a monomer into polymers and produces the transformation of a viscous paste into a reasonably solid final product.⁽⁶⁾

An adequate polymerization process is crucial for good physical properties of

VLC resin restoration. Light polymerization is influenced by various factors such as composition and quality of light-curing unit, exposure time, and material thickness.⁽⁷⁾

Hardness is define as the resistance of material to penetration when indented by hard object. A material possessing a higher surface hardness is, in general, considered to be more wear resistance⁽⁸⁾.

Measuring hardness of the composite resin materials to evaluate polymerization is a frequently used technique. Because of its accuracy and relative simplicity. This is the most favorable indirect method for investigating the degree of conversion.⁽⁹⁻¹¹⁾

Denture base polymer should have good esthetics with a smooth and glassy surface and be capable of matching the natural appearance of the soft tissues⁽¹²⁾. Color stability is an important clinical behavior for all dental restorative materials⁽¹³⁾. Color measurements carried out by

using an ultraviolet–visible recording spectrophotometer^(12,14).

The fracture resistance of denture base polymers has been the subject of many investigations. A number of clinical reports have demonstrated that midline fracture of maxillary complete dentures present a common problem^(15,16). Ensuring the transverse strength of acrylic resin is generally considered sufficient to resist fracture caused by the application of masticatory load⁽¹⁷⁾. Both visible light-cured and heat-cured resin have comparable values for transverse strength⁽¹⁸⁾.

The aims of this study was to evaluate the hardness, fracture resistance and color stability of visible light cure denture base cured by different curing times.

MATERIALS AND METHODS

Ninety six VLC denture base material (Megadent, Germany) bars with following dimensions (length, width and thickness respectively) $30 \times 15 \times 2.5 \pm 0.03$ mm for hardness test, $65 \times 10 \times 2.5 \pm 0.03$ mm for transverse strength test and $45 \times 10 \times 2.5$ mm for color change were prepared (Thirty two samples for each)^(19,20).

Each one of these samples was prepared by cutting the VLC denture base sheet on glass slab to the specific dimensions for H, TS and CS test by using cutter.

The samples were polymerized by using VLC material curing machine chamber (Megadent, Germany) for 5, 10, 15, and 20 minutes. Then the samples were stored in distilled water at 37 °C for 48 before⁽¹⁸⁾ hardness testing measurement and transverse strength, and for 7 days before color stability testing measurement.⁽¹¹⁾

The samples that prepared for H was tested by using Rockwell hardness machine, with 60 kg major applied load and 0.5 inch diameter of indentation steel ball. Each samples was measured at 5 different areas and the mean Rockwell hardness number was calculated. While, for transverse strength test the samples were tested by Instron universal testing machine, whereby the simple specimen beam was centrally loaded at a crosshead speed

of 5 mm/min over a 2-point support span set at 50-mm. The specimens were deflected until rupture occurred. The stress was calculated by means of the following equation:

$$S = 3PL/2bd^2$$

where S is the stress in the outer surface at midspan, expressed in MPa; P: load at a given point on the load-deflection curve, expressed in N; L: support span length, expressed in mm; b: width of beam tested, expressed in mm; and d: depth of beam tested, expressed in mm.

The color stability measurement was carried out by using computerized UV spectrophotometer⁽²⁰⁾ (CECIL 2000, Japan). The Lambda max(λ max) of VLC material (Megadent) was obtained by using ultraviolet–visible spectrophotometer that calculated as 375 nm.

The UV spectrophotometer was set at λ max 375 nm then the samples was tested to compare the color change that may be occurred due to different curing times.

Mean, standard deviation, and analysis of variance (ANOVA) was performed to compare statistically the obtained result ($P \leq 0.05$).

RESULT AND DISCUSSION

Table(1) showed that the mean and standard deviation of Rockwell hardness number(RHN). Table (2) demonstrated the analysis of variance of RHN for VLC denture base in which that no significant differences between different curing times(5–20 minutes) ($P = 0.062$).

In this study the RH test was used in which the RHN are found by an indentation made by steel ball⁽⁵⁾. This study showed no differences between RHN with different curing times(Table 2) and the plausible explanation may be due to that VLC denture base had trace or no residual monomer in which that the presence of residual monomer on denture surface reduce resin hardness. In addition to that the VLC denture base had inorganic filler in its composition so there was a reduction in proportion of the resin matrix^(5, 21).

Table (1): Mean and standard deviation for Rockwell hardness number of different curing times of visible light cure material.

Curing times	Number of samples	Mean \pm SD
5 minutes CT	8	100 \pm 5.42
10 minutes CT	8	96.75 \pm 2.82
15 minutes CT	8	99 \pm 4
20 minutes CT	8	102.88 \pm 1.55

CT: curing time; SD: Standard deviation.

Table (2): Analysis of variance for Rockwell hardness number of different curing times of visible light cure material.

Source of variance	DF	Sum of square	Means of square	F-value	P-value
Different curing times	3	114.3	38.1	2.73	0.062
Error	28	390.4	13.9		
Total	31	504.7			

DF: Degree of freedom

The analysis of variance for transverse strength of VLC denture base expressed that there was no significant differences between different curing time Table (3,4) ($P \geq 0.05$).

There was no statistical difference when comparing the transverse strengths of the VLC denture base tested materials (Table 3). The stiffness of denture base was related to the amount of porosity, free monomer, and polymeric chain^(22,23), and as the VLC denture base is monomer free and low porosity so the different curing time would not affect the material strength.

Table (4) revealed the mean and standard deviation of color stability of VLC denture base. While Table (5) displayed the ANOVA of CS of VLC denture base and explained that there was no significant differences between different curing times at $P \leq 0.05$.

The two main factors that affect the

optical properties of acrylic resin are residual monomer and porosity^(24,25). So the higher color stability (table 6) with different curing times of VLC denture base may be explained by that lower manufacturer residual monomer content of materials and no porosity formed by curing process and presence of organic filler which cause short polymer chain and matrix.

There is no previous studies for the effect of different curing times on the VLC materials that support this study.

CONCLUSIONS

Within the limitation of this study the visible light cure denture base was a hard material and not effected by the curing times and had a higher color stability what ever the curing times are. The stiffness of the materials will not affected by increasing the curing times.

Table (3): Mean and standard deviation for transverse strength of different curing times of visible light cure material.

Curing times	Number of samples	Mean \pm SD (Mpa)
5 minutes CT	8	86.62 \pm 6.09
10 minutes CT	8	90.18 \pm 3.34
15 minutes CT	8	90.56 \pm 3.48
20 minutes CT	8	89.25 \pm 1.79

CT: curing time; SD: Standard deviation.Mpa: Mega Pascal

Table (4): Analysis of variance for transverse strength of different curing times of visible light cure material.

Source of variance	DF	Sum of square	Means of square	F-value	P-value
Different curing times	3	75.7	25.2	1.58	0.216
Error	28	446.1	15.9		
Total	31	521.7			

DF: Degree of freedom

Table (5): Mean and standard deviation for color stability of different curing times of visible light cure material.

Curing times	Number of samples	Mean \pm SD(nm)
5 minutes CT	8	2.577 \pm 0.036
10 minutes CT	8	2.922 \pm 1.074
15 minutes CT	8	2.498 \pm 0.025
20 minutes CT	8	2.680 \pm 0.031

CT: curing time; SD: Standard deviation. nm: nano meter

Table (6): Analysis of variance for color stability of different curing times of visible light cure material.

Source of variance	DF	Sum of square	Means of square	F-value	P-value
Different curing times	3	0.814	0.271	0.94	0.435
Error	28	8.098	0.289		
Total	31	8.912			

DF: Degree of freedom

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