The effect of heat polymerized-acrylic resin disinfected with sodium hypochlorite and castor oil (*Ricinus communis oil*) colour stability

Kavita Gandhi[1*], Putri Welda Utami Ritonga[1]

[1]Department of Prosthodontics, Faculty of Dentistry Universitas Sumatera Utara, Indonesia

ABSTRACT

Introduction: The 1% sodium hypochlorite and Castor oil are disinfectants which show good bactericidal and fungicidal properties, although sodium hypochlorite is more commonly used. However, the use of 1% sodium hypochlorite could influence the color stability. In other hands, Castor oil does not cause any significant changes on the color stability of the acrylic resin. This research, therefore, was aimed to analyse the effect of heat polymerized acrylic resin base disinfection with sodium hypochlorite and castor oil (*Ricinus communis*) oil on colour stability. **Methods:** This research was laboratory experimental research. The total of 30 samples was determined by using Federer's formula, divided into 3 groups with different disinfection treatment: Group A (1% Sodium Hypochlorite); Group B (10% Castor oil (*Ricinus communis*); and Group C (distilled water) as control group. The sample was obtained from the master model based on the ADA No.12 specification and was needed to calculate color stability. All data was then statistically analysed with the Kruskal-Wallis test, followed by an LSD test. The measurement of color stability was performed using a UV-Vis Spectrophotometer following the Beer-Lambert Law. **Results:** Color stability results for group A, B, and C were 0.059 ± 0.038, 0.105 ± 0.041 and 0.136 ± 0.052, consecutively. The Kruskal-Wallis test results obtained a significance level of $p = 0.005$ ($p < 0.05$) indicated a difference in the color stability of heat polymerized acrylic resin denture after disinfected with 1% sodium hypochlorite and 10% castor oil. Disinfection of 1% sodium hypochlorite causes the change in the colour stability of the heat polymerized acrylic resin compared to the control group, while disinfection of 10% castor oil did not. There was found a significant difference in the colour stability of the heat polymerized acrylic resin between disinfection with 1% sodium hypochlorite and 10% castor oil ($p = 0.027 < 0.05$). **Conclusions:** The colour stability of heat polymerized acrylic resin is not changed after disinfection with 10% Castor (*Ricinus communis*).

Keywords: Disinfection; sodium hypochlorite; castor oil; acrylic resin; denture base

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[*]Corresponding author: Kavita Gandhi, Department of Prosthodontics, Faculty of Dentistry Universitas Sumatera Utara, Indonesia. 2, Jalan Alumni, Medan, North Sumatra, 20155, Indonesia. Phone: +60 12-403 6191; e-mail: ativakg@gmail.com

INTRODUCTION

Denture base is a part of the denture which serves to improve the contour of the tissue so that it can return to its original state. Heat polymerized acrylic resin is widely used polymer for denture bases making.[1] The ability of the denture base to absorb fluids is related to the ability of certain microorganisms to colonize the surface of dentures, for example *Candida albicans*.[2] The presence of biofilms on dentures that are in contact with the surface of oral tissue is one of the significant factors that cause denture stomatitis. Biofilm formation caused by *Candida albicans* in dentures must be disinfected every day to prevent the onset of oral and systemic diseases.[3]

According to the American Dental Association (ADA) sodium hypochlorite with a concentration of 1% is a commonly used disinfectant and shows good bactericidal and fungicidal properties, compared to other chemical disinfectants.[4] The World Health Organization (WHO) recommends the search for substances and products originating from animal, plant and mineral sources. At present, the product that is being studied in all fields of health is castor oil (*Ricinus communis*).[5] Castor oil is biocompatible and has a bactericidal and fungicidal effect.[6]

Colour stability is considered a significant clinical characteristic for all dental materials because color changes indicate aging or damage to a material. In addition, patients often give aesthetic importance.[7] Thus, it is important to study the effect of disinfecting agents on the stability of the color of heat polymerized acrylic resin. Sodium hypochlorite can reduce the properties of acrylic resin which causes discoloration.[8] However, discoloration in the denture applies if it is soaked too long or used in high concentrations. According to Porwal, et al and Arruda, et al.[9,10] the concentration of 1% sodium hypochlorite did not cause discoloration in dentures after 7 days of immersion.[9,10]

Water molecules present in 10% castor oil can act as a plasticizer resin which causes changes of the color stability in acrylic resin.[11] However acrylic resin is stated to have good resistance to water molecules due the presence of cross-linking property that is resistant to disinfectants and prevents changes in color stability. This can be seen in the in the research done by Pisani, et al.[12] and Salles, et al.[12,13] where the result stated that there are no changes in the color stability of acrylic resin caused by castor oil because of the presence of cross-linking that is resistant to disinfectants and prevents changes in color stability.[12]

Previous research from Salles, et al.[13] evaluated 2% castor oil and showed insignificant color changes in acrylic resin. Since Castor oil is has desirable properties such being a biocompatible disinfectant and barely causes any color changes towards resin acrylic, therefore research is done to compare sodium hypochlorite, which is used commonly as a disinfectant and Castor oil in order to find a much desirable disinfectant. The purpose of this study is to analyze the effect of disinfecting heat polymerized acrylic resin denture base with sodium hypochlorite and castor oil (*Ricinus communis* oil) on color stability.[11,12]

METHODS

This research was laboratory experimental research. The sample used in this study was heat polymerized acrylic resin cylinders with a diameter of 50 ± 0.1 mm and thickness of 0.5 ± 0.1 mm for color stability based on American Dental Association (ADA) No.12 specifications.[14] In this study, the sample was divided into 3 groups, namely: Group A: disinfection with 1% Sodium Hypochlorite; 2. Group B: disinfection with Castor oil (Ricinus Communis Oil) 10%;3. Group C: disinfection with distilled water (control group), because the variables to be examined were on color stability, the total number of samples was 30, which was determined by using Federer's formula.

The initial stage is the manufacturing of heat polymerized acrylic resin samples (poly methyl methacrylate powder and Methyl methacrylate liquid). The samples were then immersed in distilled water for 48 hours to remove the remaining monomers. The sample was soaked for 15 days for the assumption of 3 years according to Arruda, et al[10] and Pisani, et al.[16] The sample was removed and left to dry, then a color stability test was carried out. The measurement of color stability in this study was done by using a UV-Vis Spectrophotometer by using the Beer-Lambert Law.

The measurement of color stability in this study was done by using a UV-Vis Spectrophotometer by using the Beer-Lambert Law : A= εcl, whereby **A** is absorbance of the sample, **ε** is the molar absorption coefficient (which depends on the nature of the chemical and the wavelength of the light used), **c** is the molar concentration of a given sample, and **l** is the optical path length light must travel in the sample in centimetres. The higher value, the more the effect on the color stability. The statistical test used in this study is the univariate test to see the mean and standard deviation of the sample with the Kruskal-Wallis test and Least Significant Difference (LSD) test to determine the effect and difference of disinfecting heat polymerized acrylic resin denture base with 1% sodium hypochlorite and 10% castor oil (*Ricinus Communis Oil*) on color stability. The research was done in the Research Laboratorium, Faculty of Pharmacy, Universitas Sumatera Utara Ethics Commission agreement on the implementation of health research no: 673/DATE/KEPK FK USU-RSUP HAM/2018.

RESULTS

Table 1 shows the color stability heat polymerized acrylic resin after disinfecting for 15 days with groups A (1% sodium hypochlorite), B (10% castor oil) and C (aquadest as control group). The smallest absorbance value in group A is 0.021 and the largest value is 0.123, and the mean value and standard deviation is 0.059 ± 0.038. The smallest absorbance value in group B is 0.020 and the largest value is 0.166, and the mean value and standard deviation is 0.105 ± 0.041. The smallest absorbance value of group C is 0.054 and the largest value is 0.242, and the mean value and The Kruskal-Wallis test results obtained significance level of p = 0.005 (p < 0.05) indicating that there was an effect on the color stability change of disinfecting of heat polymerized acrylic resin denture base with groups A, B and C groups on color stability values (Table 1).

The Least Significant Difference (LSD) test showed group A (p = 0.001 < 0.05) with significant differences (Table 2) standard deviation is 0.136 ± 0.052.

The Kruskal-Wallis test results obtained a significance level of p = 0.005 (p < 0.05) indicating that there was an effect on the color stability change of disinfecting of heat polymerized acrylic resin denture base with groups A, B and C groups on color stability values (Table 1). The Least Significant Difference (LSD) test showed group A (p =0.001<0.05) with significant differences (Table 2)

Disinfection of 1% sodium hypochlorite causes the change in the colour stability of the heat polymerized acrylic resin compared to the control group, while disinfection of 10% castor oil did not. There was found a significant difference in the colour stability of the heat polymerized acrylic resin between disinfection with 1% sodium hypochlorite and 10% castor oil (p = 0.027 < 0.05).

Table 1. Color stability on heat polymerized acrylic resin denture base after disinfection using 1% Sodium hypochlorite, 10% castor oil (Ricinus Communis oil) and distilled water for 15 days

Sample	Color stability		
	A	B	C
1	0,059	0,109	0,116
2	0,033	0,127	0,054*
3	0,123**	0,166**	0,081
4	0,098	0,084	0,123
5	0,114	0,136	0,160
6	0,039	0,129	0,159
7	0,021*	0,066	0,242**
8	0,033	0,116	0,130
9	0,032	0,096	0,122
10	0,033	0,020*	0,175
$\bar{X}$ ± SD	**0,059 ± 0,038**	**0,105 ± 0,041**	**0,136 ± 0,052**
P	0,005	0,005	0,005

Description: *Smallest value **Highest value Kruskal-Wallis test)

Table 2. Difference on the effect of disinfecting heat polymerized acrylic resin denture base with 1% sodium hypochlorite and 10% castor oil on color stability

Group	Mean difference	P
A (1% NaOCl) to C (Control)	0.078	0.001*
B (10% castor oil) to C (Control)	0.031	0.125
A (1% NaOCl) to B (10% castor oil)	0.046	0.027*

DISCUSSION

In table 1, it can be seen that the absorbance values of color vary between each sample in a group. The difference in absorbance value may be due to the different disinfecting mechanism and effect between 1% sodium hypochlorite, 10% castor oil, and distilled water. In group C (control), distilled water is clear and does not cause discoloration on the heat polymerized acrylic resin denture base. The Kruskal-Wallis test in table 1 shows that there is an effect of disinfecting heat polymerized acrylic resin denture base with groups A (sodium hypochlorite 1%) and group B (castor oil 10%) on color stability. The absorbance value of color shows the amount of light absorbed by the sample and the concentration of the substance in a sample. Group A has the lowest absorbance.

The influencing factor is because hypochlorite damages the color molecule in the heat polymerized acrylic resin or converts it the double bonds into a single bonds that reduces the absorption of visible light and only white light is reflected back. The result of this study is incompatible Porwal, et al.[9] where high sodium hypochlorite concentrations such as 5.25%, caused bleaching or discoloration after 7 days of immersion but did not show discoloration in 1% sodium hypochlorite. Arruda, et al[10] also showed 1% sodium hypochlorite did not cause discoloration of acrylic resin in a 20 minute immersion simulation for 180 days.[10] The result of this study could be incompatible with the previous results due to the duration of the samples where soaked in 1% sodium hypochlorite, whereby the simulation is to show the samples where soaked 180 days, hence causing a difference in the color stability.[9]

Group B which was disinfected with 10% castor oil had a high absorbance value so there are no changes in the color stability. Changes in color stability are able to occur because acrylic resin has the tendency to absorb water or solution and this absorption occurs because of the hydrophilic nature of polymethylmethacrylate (PMMA) and porosity that occurs when acrylic resin is heated. It is evident that the mechanism is the diffusion of water molecules that penetrate the acrylic resin according to the law of diffusion.

A 10% castor oil solution can act as a resin plasticizer because its water molecules can diffuse into the polymer resin and cause the release of polymer chains. This will cause a change in the color stability of acrylic resin, but high bonding due to cross-linking makes it resistant to change. According to the Pisani MX et al.[12] there is no change in the color stability of acrylic resin due to cross-linking which is resistant to disinfectants and prevents changes in color stability.

The results of this study are consistent with previous studies from Salles MM, et al.[13] which evaluated 2% castor oil and showed insignificant changes in surface roughness and hardness, and the base color of acrylic resin.[13] The results of this study are also in accordance with the study of Roselino LMR, et al.[11] which used castor oil toothpaste to disinfect acrylic resin denture elements and the study showed no change in color stability of denture and castor oil can be used for denture disinfection.[1]

The result of this study is similar to the previous results is due the property of Castor oil, whereby Castor oil is biocompatible and Ricinoloic acid component in castor oil is a weak acid which does not cause effect on the color stability on the samples.[12] Based on the LSD test in table 2, the results of the color stability value of group A had the most significant difference, namely ($p = 0.001 < 0.05$). This is because even though the concentration of sodium hypochlorite used is low, the sample is disinfected for a long time for 15 days (3-year simulation).

According to Porwal et al[9] hypochlorite destroys color molecules in acrylic resin and discoloration in dentures happens if soaked too long or used in high concentrations. Since A2 group sample is disinfected for 15 days (3 years

simulation), the long time duration can cause changes in color stability in hot polymerization acrylic resins. When the LSD test results show there is no significant difference in stability for castor oil which is the value (P = 0.125> 0.05). The factor is because the heat polymerization acrylic resin has good resistance to weak acids.[15] Castor oil is biocompatible and the component of castor oil, ricinoleic acid is a weak acid where the pH value is 4.99.[16]

So the color changes that occur are not significant. Weakness and limitations of this research would be that the samples were done manually, whereby the end product of the heat polymerised acrylic may differ for each of samples especially in the polishing process with sand paper with a rotary grinder. It is difficult to hold and maintain the samples on the surface of the tool because of the high rotation speed of the tool which causes a difference in pressure and thickness for each surface of the samples. Suggestions for further research developments would be on the effect of Castor oil (*Ricinus Communis Oil*) on different physical and mechanical properties of the heat polymerised resin acrylic.

CONCLUSION

Sodium hypochlorite 1% causes slight changes on the colour stability of the heat polymerized acrylic resin. When compared with sodium hypochlorite 1%, castor oil 10% does not affect the colour stability of the heat polymerized acrylic resin.0

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