Changes in the Color of the Denture Elements After Immersion in Coffee and Denture Cleaning

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Abstract. The color stability of denture elements is an essential factor in denture aesthetics. Coffee consumption may cause denture staining. Denture cleaning is a method to maintain the cleanliness of dentures. This study aimed to determine the effect of mechanical and chemical denture cleaning on the color stability of denture elements that have been immersed in the coffee solution. In this experimental laboratory study, thirty elements of an acrylic resin denture were immersed in the coffee solution for three days. Then the samples were divided into three treatment groups: mechanical, chemical, and control ($n = 10$). An electric toothbrush and toothpaste were used for mechanical cleaning for two minutes. In chemical cleaning, dental elements were immersed in a solution of Polident denture cleanser for three minutes. For the control group, the rest was immersed in distilled water for three minutes. The color intensity was measured using a UV-2401 spectrophotometer. The data were analyzed using one-way ANOVA. There was no significant difference in color intensity between mechanical and chemical denture cleaning ($p > 0.05$). Denture cleaning both mechanically and chemically brightened the color of denture elements that have been exposed to the coffee solution.

Keywords: Discoloration · Denture elements · Coffee immersion · Denture cleaning

1 Introduction

The prevalence of tooth loss in Indonesia is 19%. At the age of 15–24, 8.4% of tooth loss cases occurred, rising to 30.6% in those over 65 years [1]. Loss of teeth may result in displacement of the existing teethand have psychological consequences such as a lack of self-confidence and self-restriction in social activities [2, 3].

Removable Partial Dentures (RPD) is an effective and cost-effective treatment option in cases of partial tooth loss [4]. Removable Partial Dentures consist of several components: connectors, bases, clasps, and dental elements [2]. The most widely used dental element is acrylic resin. The material is lightweight, biocompatible, aesthetically pleasing, and produces no sound when occluded [5, 6].

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Dentures should generally have good color stability because it is an essential factor in aesthetics [6]. The denture interacts with the food and drink consumed by the patient, which can cause discoloration of the denture [7]. One of the most frequently consumed beverages is coffee, where the content of tannic acid and chlorogenic acid with their brownish pigment can cause discoloration [8, 9].

Denture color stability can be achieved through proper denture cleaning, both mechanical and chemical cleaning. Mechanical cleaning is the most frequently used due to its convenience and reasonableness [10]. However, it is difficult for denture users with limited motor skills [11]. Therefore, dentures can be cleaned chemically by immersing them in a chemical solution [10].

This study aimed to determine the effect of mechanical and chemical denture cleaning on the discoloration of dental elements that have been exposed to the coffee solution.

2 Materials and Methods

This study was an experimental laboratory and has received ethical approval from the Health Research Ethics Committee of the The Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta with the number 010/EC-EXEM-KEPK FKIK UMY/II/2021. A total of 30 denture elements of the maxillary incisors (Ortolux Top, Spain) were soaked in the coffee solution (Nescafe Classic, Nestle, Switzerland) for three days and incubated at 37 °C. Then, the samples were divided into three treatment groups: mechanical cleaning, chemical cleaning, and control ($n = 10$).

The mechanical cleaning used a sonic electric toothbrush (Realme N1, Realme Changqing Mobile Telecommunications Corp, China) with a scrubbing stroke of 20,000 per minute and a non-whitening toothpaste (Pepsodent, Unilever, Indonesia). Cleaning was carried out for two minutes on the labial surface of the dental elements (Fig. 1). In chemical cleaning, dental elements were immersed in a solution of Polident denture cleanser (GlaxoSmithKline, United Kingdom) for three minutes (Fig. 2). Cleaning the control group was done by soaking the tooth elements in 150 ml of distilled water for three minutes.

Then the color measurement on the labial surface of the dental elements was using a UV-2401 spectrophotometer (Shimadzu, Japan), which is the total light reflection

Fig. 1. Mechanical cleaning

Fig. 2. Chemical cleaning

value of each sample through the CIE L*a*b (Commission International deL'Eclairage) system.

Statistical analysis of the data used IBM SPSS Statistics 22 software. The data's normality and homogeneity were tested using Shapiro-Wilk and Levene's Test, respectively. The mean differences between groups were analyzed using one-way ANOVA and followed by post hoc Tukey.

3 Results

The mean color intensity of each group is presented in Table 1. The mechanical cleaning group shows the highest color intensity compared to the others.

The normality test shows $p > 0.05$ in all groups (Table 2), indicating that each group's distribution is normal. The homogeneity test with Levene showed $p > 0.05$; thus, all samples are homogeneous (Table 3).

The One-Way Anova test shows a significance value of $p > 0.05$. There is no significant difference between the three treatment groups (Table 4).

4 Discussion

The immersion of dental elements in coffee solution in this study is to observe changes in the color of the tooth elements. Compounds of caramel, tannic acid, and chlorogenic acid in coffee contribute to the discoloration of dental elements because of the brownish to blackish brown pigments. The nature of acrylic resins can absorb water and produce a plasticizing effect, thus triggering the stretching of polymer chains. The molecules do not bind, resulting in the formation of empty gaps. Furthermore, liquid diffusion and pigment degradation occur in the acrylic resin material [12].

This study showed that the highest mean color intensity was found in dental elements that received mechanical cleaning treatment. The dE*ab value is a benchmark for the amount of color intensity absorbed by each sample. If the reflected light's total value increases, the value of dE*ab will be higher. Thus, the higher the dE*ab value, the higher

Table 1. Mean of dE*ab.

Specimen's number	Mechanical cleaning	Chemical cleaning	Control
1	39.70	37.30	33.95
2	25.72	30.50	32.43
3	30.01	31.59	30.69
4	25.70	28.92	37.51
5	32.81	20.52	27.32
6	35.53	33.89	37.90
7	29.46	36.30	27.25
8	35.68	23.39	24.63
9	34.97	30.23	23.54
10	26.81	38.61	23.61
Total	316.39	311.25	298.83
Mean	31,639	31,125	29,883

Table 2. Normality test

Factor		Shapiro-Wilk		
		Statistic	df	Sig.
Cleaning method	Mechanical	0.929	10	0.439
	Chemical	0.944	10	0.600
	Control	0.910	10	0.280

Table 3. Homogeneity test

Levene statistic	df1	df2	Sig.
0.087	2	27	0.917

Table 4. One-Way Anova test

	Sum of squares	Df	Mean square	F	Sig.
Between groups	16.301	2	8.150	0.281	0.757
Within groups	783.893	27	29.033		
Total	800.194	29			

the level of color brightness in the teeth [13]. However, statistical analysis showed that the p value is >0.05, meaning that the difference in color intensity between the samples cleaned mechanically, chemically, or with distilled water is not significant.

Mechanical cleaning in this study used a sonic electric toothbrush combined with toothpaste. This combination can increase the brightness of the color on acrylic resin materials [14]. Toothpaste contains abrasive ingredients, which is essential for preventing extrinsic stains on teeth. One of the abrasives used is calcium carbonate with the active ingredient in sodium monofluorophosphate [15].

The movement produced by the sonic electric toothbrush is a vibration where the bristles will vibrate from side to side to remove plaque on the teeth. Therefore, an active movement is needed when moving a sonic electric toothbrush, such as when brushing with a manual toothbrush [16]. In this study, the sonic electric toothbrush was not actively moved and only positioned against the surface of the tooth elements at one point, which may cause the mechanical cleaning process inefficient.

Chemical cleaning in this study used effervescent tablets containing sodium perborate. Sodium perborate effectively removes coffee stains on the denture elements through its micromechanical cleaning action and releases oxygen bubbles from the reaction of sodium perborate solution [7, 17].

A Spectrophotometer with the CIE L*a*b system is a popular tool used to determine color stability in vitro [18]. However, other tools, such as the tristimulus colorimeter with the CIEDE2000 system, can better evaluate color changes than the CIE L*a*b system [19]. Therefore, the researchers suggest to use this system in future research. In addition, manual brushing may result in uncontrolled pressure of the toothbrush touching the denture elements. For future studies, it is necessary to use a particular machine for brushing.

5 Conclusion

Mechanical and chemical cleaning gave the same effect as better color on dental elements exposed to the coffee solution. However, the mechanical cleaning produced a more excellent color brightness than the chemical cleaning.

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