Original Research

Evaluation of the Effect of 2 Flask Investment Materials on Color Stability of 5 Brands of Denture Teeth

Fariborz Vafaee[1], Sara Tavakolizadeh[2], Mahdi Kadkhodazadeh[3], Masoume Khoshhal[4]

[1] Dental Research Center, Department of Prosthodontics, Hamadan University of Medical Science, Hamadan, Iran
[2] Department of Prosthodontics, Shahid Beheshti University of Medical Science, Tehran, Iran
[3] Department of Periodontics, Shahid Beheshti University of Medical Science, Tehran, Iran
[4] Department of Periodontics, Hamadan University of Medical Science, Hamadan, Iran

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Abstract

Introduction: The purpose of this study was to investigate the effect of flask investment materials on the color changes of different brands of resin denture teeth. **Methods:** Resin denture teeth (560) were divided into 2 groups according to the materials used for flask investment (silicone or gypsum). All the specimens were thermocycled between 4°C and 60°C with 60-s dwell times for 1,000 cycles. Subsequently, the specimens of each group were divided into 4 subgroups based on the immersion media: coffee, tea, cola, and distilled water. Digital images of the teeth were taken before immersion and 30 days after immersion. The color samples were measured using the CIE L*a*b* system, and color differences (ΔE) were calculated. The data were evaluated by three ways ANOVA and the Tukey HSD test. **Results:** There was not a significant difference in ΔE using three-way ANOVA, while the results showed considerable statistical differences with two factor ANOVA interaction. The ΔE values in the silicone group were significantly more than those in the gypsum group ($P<0.001$). Among the solutions in which specimens were kept, maximum discoloration was seen with coffee followed by cola, tea, and distilled water. The Ivoclar Vivadent denture teeth in the silicone group, as well as the Apple teeth in the gypsum group exhibited the highest level of color stability. **Conclusion:** All test groups exhibited visually perceptible color changes; the denture teeth and flask investment materials, as well as the nutritional habits, significantly affected the color stability of the resin denture teeth.

Key words: Color stability, resin denture teeth, silicone and gypsum.

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Introduction

In removable dentures, artificial teeth play a significant role in the overall aesthetic outcome. Color stability of the artificial tooth is a major factor in maintaining the aesthetic aspects of the prosthesis and patient satisfaction (1-3).

Denture teeth have been historically made of either methacrylate-based resins or ceramic. However, nowadays almost all dentures are fabricated with acrylic teeth because of such advantageous properties as chemical bonding to the acrylic resin base and ease of adjustment (1,4,5). It is also true that acrylic resin teeth are more prone to wear and discoloration than porcelain denture teeth (6,7).

Color stability is the property of a material that allows the color to be maintained over a period of time in a given environment. It is an important physical property of dental materials (6).

Discoloration of restorations can be due to intrinsic factors related to physicochemical reactions in the deeper portions of the restorations or to extrinsic

factors, which depend on absorption and adsorption by the resin teeth (8,9).

Many materials used for prosthetic treatment, such as fixed partial denture acrylic resins (10-12), interim prostheses (13,14), and denture liners and bases (15,16), are subject to water sorption. These materials absorb liquid slowly over a period of time, undoubtedly due primarily to the ionic properties of the resin molecules (17,18).

Extrinsic color changes are also affected by such factors as diet (7), oral hygiene, and composition (12,19,20) and surface smoothness (21,22) of the material. These color changes can be measured visually or by the use of a photometric instrument (23). Instrumental colorimetry prevents bias due to subjective considerations, and it is recommended (24).

The process of placing and adapting denture base resin to the mold cavity is called packing or flasking (25). Gypsum and silicone have been frequently used as flasking materials; however, several advantages have been mentioned for the former. Keitet al. (26) showed that flasking with silicone was significantly more precise than flasking with gypsum. Likewise, Shibayamaet al stated that silicone flasking was the most precise method for preventing denture teeth movement during baking (27). Silicone facilitates investing by both injection and packing (28); in addition, the final prosthesis in this technique has better polishability (29,30), less porosity, and lower shrinkage in the palatal area (31,32).

Few studies have investigated the effect of flasking material on the color stability of denture teeth. Therefore, the purpose of current study was to evaluate the effect of two flasking materials on the color stability of five different brands of denture teeth after immersion in commonly consumed beverages, based on the CEL l*a*b* color system.

Materials and Methods

Five different brands of acrylic resin denture teeth (SR-Orthosit (Ivoclar/Vivadent, Schaan, Liechtenstein), Isosid TAK(BD, Tehran, Iran), Crystal ECL (BD, Tehran, Iran), Apple (Idea mako, Tehran, Iran), and Glamour(Idea mako, Tehran, Iran)) were studied. Of the largest size and A1 shade were used. From each brand, 112 specimens were used to make a total of 560 specimens. Then every brand of teeth was divided into 2 groups:

Group 1: flasking with silicone (Speedex, Colten, Swiss)

Group 2: flasking with gypsum, Type IV (Khaizaran, Isfahan)

Fourteen teeth of each brand were placed in each custom metal muffle (20 × 20 cm); 40 muffles were used in total, 20 muffles flasked using silicon and 20 falsked with gypsum.

After setting of the silicone and gypsum, deflasking was done then the specimens were thermocycled in a thermocycled for 1,000 cycles between 4°C and 60°C, using distilled water baths with a 60-s dwell time. The teeth were then immersed in 37°C distilled water for 24 hours and, after drying, a digital photo was obtained of each of them, under conditions to be described later.

To evaluate the color stability of the teeth in the various beverages, the specimens were distributed into 4 subgroups of 70 specimens each and immersed into one of the following beverages at 37°C for 1 month (N = 14):

Preparation of Beverages

1) Tea: 14 tea bags (Lipton Yellow Label tea, London, England) were immersed in 2,800 ml boiling water for 3 minutes.

2) Coffee:56 g coffee (Nescafe, classic nestle, Swiss) immersed in 2800 ml boiling water. This solution was filtered after cooling to 37°C.

3) Cola: 2,800 ml cola (Zamzam Cola, ZamzamCo., Tehran, Iran) was kept at 37°C.

4) Distilled water: 2,800 ml distilled water (Faraz Dentin Co., Isfahan,Iran) at 37°C. The solutions were changed every other day. After one month, another digital photograph was taken of each tooth under the same conditions as the baseline image.

Digital Photography

Photos were taken at a shutter speed of 1/60 s, F:20, ISO = 100, and 100 macro lens Using a digital camera (Canon EOS4D), at distance of 40 cm from each specimen. A custom made camera holder and flash holder and also special housing for specimens made in order to stabilize distance between camera and specimens. Photos were saved in TIFF format. In order to standardize the photo conditions, two halogen 60W flashlights in a dark box (80 × 40 × 40 cm) were used. The angle between the lens and the light source was 45° to reduce reflection from the tooth surface. Standard white photographic paper was placed adjacent to the specimens to calibrate the photos and eliminate the camera and environmental conditions (33).

Color Assessment

The CIE L*a*b* color system is a 3-D color space having 3 axes: L, a, and b. The advantages of the CIE L*a*b* system is that color differences can be expressed in units that can be related to visual perception and clinical significance. (34)

The middle one third of each tooth was selected with a freestyle drawing instrument in Photoshop software (CS4) to determine the average a*, b*, and L*.

The color difference (ΔE), before and after immersion in solution, was calculated for each specimen using the following formula:

$\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}$

The effect of the denture tooth brand, immersion solution, and flask investment material was analyzed by 3-way ANOVA followed by the Tukey HSD post hoctests ($\alpha = 0.05$) using SPSS software (v11).

Results

The ΔE (mean ± SD) color changes of silicone and gypsum materials were 9.16 ± 3.36and 8.43 ± 3.36, respectively. Therefore, the color stability of all denture teeth that were invested in gypsum was significantly more than of those invested in silicone.

The maximum discoloration was seen with coffee ($P < 0.005$), decreasing in descending order as follows:cola, tea, and distilled water (Table 1), and in comparison with other solutions, cola caused more color changes than water (Table 2 and Fig. 1).

The highest color stability was shown by BD crystal ECL; the least by Glamour. The color stability of BD Isosid, TAK, and Apple teeth invested in gypsum was higher than the teeth of the same brands invested by silicone. For Ivoclar Vivadent and Glamour, there was no significant statistical difference between silicone and gypsum as investing materials (Table 3).

Table 1. Average color stability of different denture teeth by emerging in different beverages

*P. value	ΔE (mean ± SD)	Study groups
0.002	25.81±3.7	Distilled water
	7.91±3.8	Cola
	76.45±3.8	Tea
	3.02±3.10	Coffee

Table 2. Color changes of denture teeth by comparison of one by one solution

Groups		Mean differences of ΔE	P value
Tea	Water	0.64	0.203
Coffee		-1.56	0.000
Cola		-0.45	0.501
Coffee	Tea	-2.20	0.000
Cola		-1.09	0.005
Coffee	Cola	1.56	0.000
*tukey			

Table 3. Comparison of two investing technique related to type of denture teeth

Study groups	Comparative groups		P. value
	gypsum	Silicon	
Ivoclar VivadentDCL	89.89±2.80	52.88±2.70	0.051
BD Isosid TAK	81.72±2.70	66.77±2.90	0.00
BD Crystal EC	78.94±2.70	80.74±2.80	0.130
Apple	4.30±3.70	94.76±3.90	0.000
Glamour	20.30±4.10	19.65±4.90	0.415

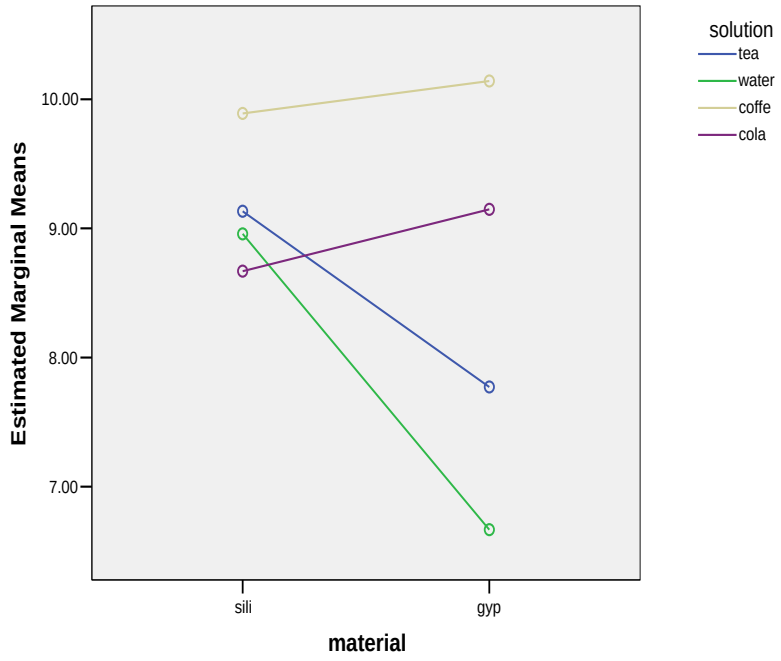

Figure 1. Interrelationship of muffling material and solutions

Discussion

Subjective color evaluation and determining its changes are often difficult because of different interpretation of color between persons. Therefore, the use of the CIE L*a*b* system for evaluation of color changes (ΔE) is recommended (35).

Lieberman et al found that a ΔE value of one is enough for visual perception of the color changes (36), but most authors agreed that ΔE values less than two cannot be recognized clinically. On the other hand, ΔE values more than 3.3 are not clinically acceptable in terms of aesthetics (10,11,37). In this study, we considered a ΔE value of three as the upper limit of clinical acceptability. Nevertheless, it should be noted that although ΔE is well accepted as a color change scale, relating this numerical value to clinical conditions is often difficult (5).

According to Table 2, the coffee solution was more choromogenous than other solutions, followed by cola and tea. However, the color changes between the cola and tea solutions were not clinically remarkable. This finding was in line with those of Ertas et al, Weded et al, and Sagsan et al. (38). On the other hand, Omata et al. showed that tea solution was more choromogenous than coffee. The difference may be because of the type of tea used.

In current study, the overall all mean ΔE for the silicone investing group was 9/16 ± 3/16 and that for the gypsum group was 8/43±3/36, of which both are unacceptable aesthetic results. These severe changes may be because of prolonged immersion of the teeth in the solutions (30days). On the contrary, the color changes of teeth after 30 days in studies by Omata et al. and Fujiti et al. were less than in current study, perhaps because their specimens were kept intermittently for 7 hours in solutions and 17 hours in artificial saliva (39,40).

In general, while the ΔE for the silicon investing group was higher than in the gypsum group, in some brands the differences were more pronounced, possibly because of the denture teeth surface characteristics after flasking and polishing. Effect of flasking may be due to different effect of flask material and polishing technique. In contrast, some studies showed that the final prosthesis had better polishability and less porosity when flasking with silicone. However, a conclusive comparison between the two materials needs further investigation, as we found no similar study in the literature evaluating the influence of the flask investment material on the color stability of resin denture teeth.

Comparing the five brands of teeth showed that Glamour had a higher ΔE than the others, while changes between the other four brands were less than one unit. Similar to other groups, Glamour denture teeth were made of resin composite. Although it was difficult to

identify the main cause of differences between the teeth in the current study, it has been reported that compositional factors such as matrix type, type and size of filler, and polymerization stage affect the color stability of resin (41,42).

Taking into account that even water immersion resulted in a remarkable color change in all groups beyond aesthetically acceptable limits, it is recommended that selection of slightly brighter shades of resin teeth can result in better color matching of dentures in the long term. Further study is warranted on the color stability of resin teeth under clinical conditions.

Conclusion

Within the limitations of the present study, it was concluded that all test groups exhibited visually perceptible color changes: Denture teeth and flask investment materials, as well as the patient's nutritional habits, significantly affect the color stability of resin denture teeth. Effect of flasking may be due to different effect of flask material and polishing technique

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Corresponding Author:
Masoumeh Khoshhal Khojasteh Zanjani
Department of Periodontics
Hamadan Dental School, Hamadan, Iran
Tel: +988138241961
Fax: +988138248030
E-mail: khoshhalsepideh@gmail.com