

Exploring Color Viability in Denture Base Material: A Pilot Study on Modifying Monomer with Various Acrylic Colors

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ABSTRACT

Aim: The objective of this study is to assess and contrast the color stability of acrylic denture base material when combined with acrylic colors utilizing various mediums.

Materials and Methods: Three groups were formed, each consisting of two samples: Group A utilized acrylic colors in an artificial salivary medium, Group B incorporated acrylic denture base in a medium containing caffeine, and Group C employed acrylic denture base in a medium containing turmeric solution. Color stability was assessed using a spectrophotometer, and statistical analysis was performed using unpaired t-tests and ANOVA tests with SPSS software version 23.0.

Results: The t-test showed that the mean ΔE values were 0.74 for Group A, 0.94 for Group B, and 1.71 for Group C (p -value=0.019, <0.05). The ANOVA test indicated ΔE values of 0.845 for B1, 0.172 for B2, 0.084 for C1, and 0.172 for C2. Notably, Group A exhibited higher color stability compared to Group B and Group C.

Conclusion: After conducting a comprehensive analysis, it has been determined that the medium containing artificial saliva exhibits a statistically significant positive impact on the color stability of denture base resin material compared to the other two groups.

1. Introduction

Prosthodontics is a branch of dentistry that has a strong connection with dental materials. The most important relationship exists between a prosthodontist and acrylic denture base. It is one of the most commonly used denture base materials, Polymethyl methacrylate, remains as a material of choice for denture fabrication because of its excellent desirable properties(1). It is cost effective and easy to manipulate in the oral environment and it has better esthetic properties, and its physical, mechanical and functional properties add to the benefits(2). An acrylic denture base is subjected to a lot of changes in the oral environment. It paves the way for deposition of biofilm on the prosthetic device(3). Polymethyl methacrylate has antimicrobial properties to improve the quality of giving comfort to the patients(4). Regardless of these advantages, there is a need to improve its rigidity or fracture resistance, surface roughness and stability for color(5).

Color stability is the most important characteristic feature of any acrylic denture base. Discoloration of the dentures shows signs of aging or damage due to intrinsic factors like degradation of ingredients, water sorption, dissolution of intrinsic dye, amount of residual monomer and its conversion and extrinsic factors like surface roughness, stain accumulation etc. The alteration of color of denture base attributes to oral hygiene and dietary habits of patients as well(6,7).

Oxidation of the amine present as an accelerator contributes to the discolouration of the acrylic denture base. Polymethyl methacrylate has shown gradual water absorption periodically. When it comes to the

heat, polymerised denture based material shows better color stability as compared to auto polymerized denture base material because of the oxidation of amines(8,9). This can be avoided by using autopolymerizing denture base materials which are not based on benzoyl peroxide aromatic amine initiator systems. These have been proved to have a better color stability(10).

Chromatic differences can be calculated through two systems, namely, the Munsell system and the standard one which is recommended for dental materials- the CIE Lab (International Commission on Illumination). A characteristic of denture base resin is the value obtained through the CIELAB system. It consists of three values, namely, L* which measures the lightness to darkness, a* measures redness to greenness and b* measures the blueness to yellowness. ΔE is thereby the color difference between the specimens. (11,12).

Translucency and a good depth of color is assured in intrinsic pigmentation. This helps improve the color stability of the denture base material since the pigments are intrinsically added in the doughy stage of the acrylic resin material after which polymerisation occurs (13). Acrylic pigments mostly contain methyl methacrylate as the reactive resin which uses only deionized water to ensure full polymerisation. Polymerisation is complete when monomers remain firmly linked in long chains and convert into long, hard polymer chains of 70-95%. But this process can be negatively affected by various factors like temperature, humidity, incomplete reactions, undeclared chemical additions. This process of bulk polymerisation happening in dental materials is proved to be more efficient than the suspension polymerisation(14).

The study aimed to assess and compare the color stability of denture base resin material under the caffeine medium. Measurable objectives included evaluating the effect of intrinsic pigments on the color stability of denture base acrylic resin, with the null hypothesis stating that pigments had no positive influence.

2. Materials And Methodology

2.1 Preparation of Specimens:

Two groups taken for this study were the denture base acrylic resins with and without addition of acrylic pigments. Each group contained 6 samples making a total of 12 disc shaped samples involved in the study.

2.2 Preparation of Group A Group B and Group c:

By following the manufacturers instruction of 2:1 ratio, the powder and liquid were dispensed in proper proportion giving us 3 samples (A1- A3) in Group A, 3 samples (B1- B3) in Group B, 3 samples (C1- C3) in Group C.

After mixing in proper proportions, the samples were packed in disc molds in the doughy stage. Once the discs hardened and was set, it was removed from the mold. Furthermore, the excess flash was trimmed, samples were polished using a polishing bur ensuring a smooth surface. (Figure 1).

The samples were immersed in artificial saliva for a week (Figure 2). After drying the samples completely, they were checked for color stability using the advanced Konica Minolta Spectrophotometer (Figure 2). These high quality portable spectrophotometers measure light reflected from a given surface or object. Konica Minolta's portable handheld spectrophotometers can be used to measure solid, opaque, clear, or even translucent samples.

2.3 Calculation of color stability:

With the help of the above mentioned spectrophotometer, the values of L,a,b were obtained. In order to determine the difference in alteration, the standard formula of ΔE was used. These ΔE values were compared and statistical analysis was done using the SPSS software version 23.0. The formula used for calculation was: $\Delta E(L^*a^*b) = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]$

3. Result

Figure 3 shows that the t-test between Group A and C revealed a significant value of 0.084 (<0.05). The ΔE value is inversely proportional to color stability. Table 1 and Figure 3 shows the mean value of Group A is 0.80, Group B is 0.94 and Group C is 1.71. Therefore, Group A acrylic denture which is in the artificial saliva medium shows more color stability than other groups B which contain caffeine and the group C turmeric solution. This graph represents the mean ΔE value of Group A, Group B and Group C. X-axis denotes all three groups and Y-axis denotes the mean score of the three groups. The graph shows that the mean score is 0.74, 0.94 and 1.71 of Group A, Group B and Group C respectively with a p value of 0.082 (<0.05).

4. Discussion

High quality publications have been contributed by our team through their extensive knowledge and remarkable research experience (15–29). The denture base materials which are used in the fabrication of dentures are exposed to a variety of changes including the pH of saliva, the oral temperature and also contact with food and drinks at different levels bringing about changes in their physical structure (30). Change in the color absorbent values, formation of coloured degradation products, anhydration, weak bonding, oxidation of reacted carbon-carbon double bonds contribute to change in color stability (31).

The CIELAB system is advised by the American Dental Association for determining chromatic disparities. With the aid of L^* , a^* , and b^* values, it offers color information about the object, from which the magnitude of color differences E is derived (32). According to Johnson and Kao, a clinically acceptable E value in the field of dentistry is between 1 and 2. (33). According to a different study by Goldstein and Smith, when an E value is more than 3.7, it is no longer clinically acceptable and becomes visibly discernible (34). Given these circumstances, all of the specimens in our study's color changes are clinically acceptable (Table 1).

According to Figure 3 above, the control specimens showed the least amount of color change. Since Group A's E value didn't contain any acrylic pigments, it had greater color stability than Group B. All samples are known to exist and have a chemically comparable structure; the only difference is the amount of pigment used. Due to molecular interactions with the denture polymers at varying degrees, which cause acrylic resin to discolor, this results in a discrepancy in the values of color stability. Due to molecular interactions and electrostatic charges, the hydrophilic nature of PMMA makes it more apt to cling to surfaces (35). Based on the mechanism of the law of diffusion, the resin molecules tend to absorb colors because of their polar qualities (36,37). The elements contained in During the polymerization stage, are involved in the chemical activation of the acrylic resin ingredient. The release of monomers during the cycle is likely to produce instability in the color and changes in the material's physical properties. (38).

Researchers are becoming more interested in color stability, and it's important to locate the best denture base material that will look attractive and will ultimately satisfy the patient. The study's shortcomings are noted to be its small sample size and that it was conducted in a simulated environment rather than in an actual oral environment. Therefore, it is necessary to conduct in vivo experiments with a higher sample size in order to develop the appropriate denture base material.

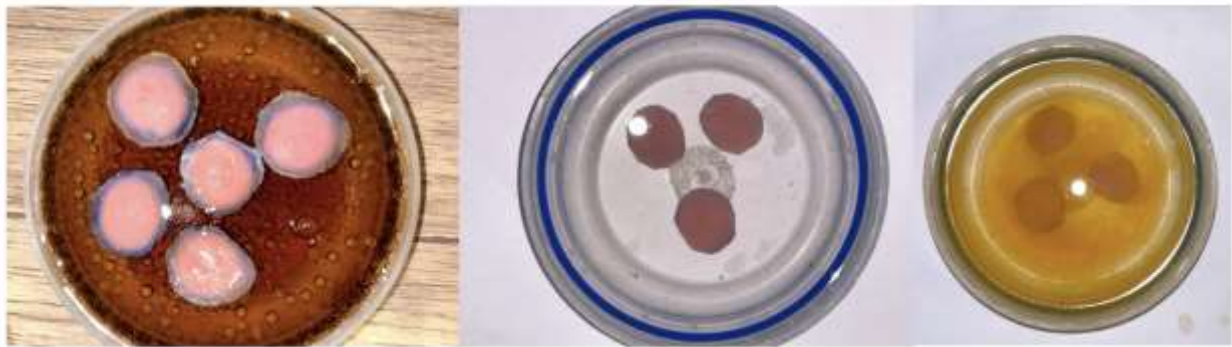


Figure 1: Immersion of samples in all 3 mediums (Artificial saliva,caffeine and turmeric solution)



Figure 2: Spectrophotometer

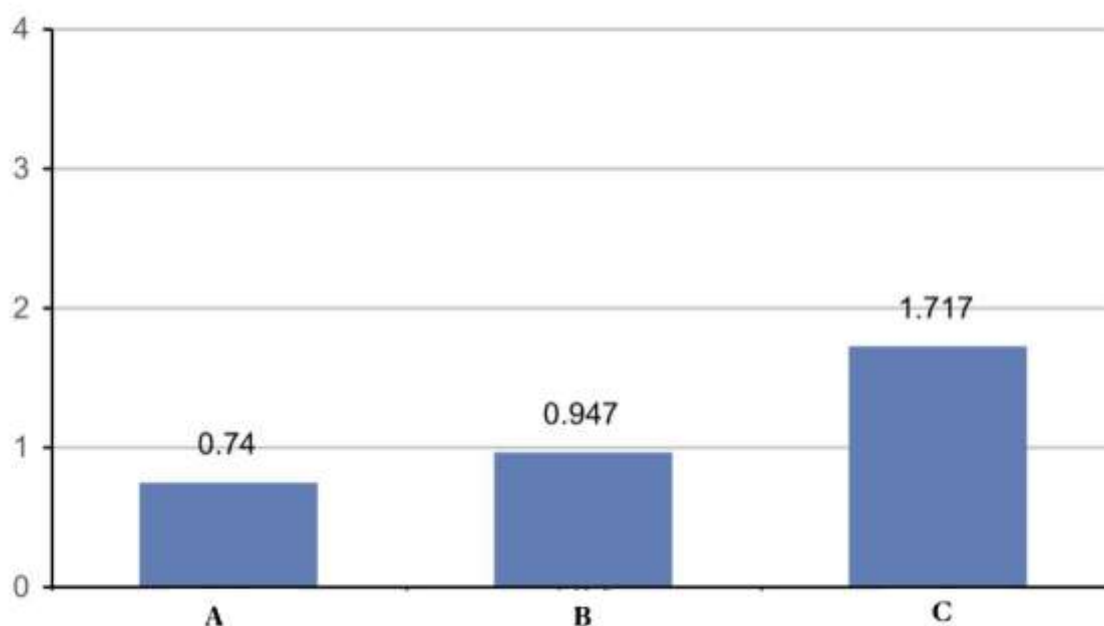


Figure 3: Graph Depicting the Mean ΔE values for Group A, B and C

5. Conclusion

We draw the conclusion that ΔE is directly related to color stability within the constraints of the study. It was discovered that samples in the artificial salivary medium had higher color stability than the sample in the caffeinery medium after the study examined and compared the color stability of denture base material with normal artificial salivary and medium containing caffeine. It has been discovered that the caffeinery medium has a less stable effect on the color stability of denture material.

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