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Original Research Article

Comparison of two surface sealants on surface roughness and color stability of a commercially available denture base material – An in vitro study

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ABSTRACT

Purpose: Comparison of two surface sealants on surface roughness and color stability of a commercially available denture base material.

Materials and Methods: Metallic discs were invested in a denture flask using dental stone to prepare a mold space. The denture base polymer and monomer were mixed in a ratio of 3:1 by volume and processed to form disc disc-shaped specimen. All the samples were finished, polished and checked for surface roughness. Sealants were applied on denture base material and cured using light-curing unit. All the 120 samples were divided into Group I(n=60) – Lucitone 199 and Optiglaze, and Group II(n=60) – Lucitone 199 and Easy Glaze. All the specimens were further subdivided into three groups based on the solution they were immersed i.e, coffee (n=20), tea (n=20), and distilled water (n=20). The specimens were checked for surface roughness and color stability for one week, one month, two months, three months, and four months. Samples were checked for surface roughness using optical profilometer and colour change using a spectrophotometer.

Results: The surface roughness of all the samples was within the normal range and tea-stained higher compared to coffee samples for color stability.

Conclusion: The study concluded that Optiglaze is a better sealant compared to Easy Glaze with better properties like less surface roughness and good color stability of commercially available denture base materials. All groups had surface roughness less than the plaque accumulation threshold (0.20 μm). Beverages affected color stability of commercially available denture base materials after the application of two different surface sealants.

1. Introduction

Acrylic resin has a wide application in dentistry as for bases of removable partial dentures, complete dentures, a tooth supported or implant-retained overdentures, orthodontic appliances, stents, surgical guides for implant placement, and temporary crowns. Prosthodontic appliances should have a smooth and highly polished surface to maintain comfort and health of oral tissues and to prevent the colonization of microorganisms and plaque accumulation and staining.[1]

Denture base resin may be exposed to different conditions for long periods, resulting in varying degrees of staining, discoloration, and distortion, caused by intrinsic and/or extrinsic factors. Intrinsic discoloration is associated with the structure and physicochemical properties of the denture base resin materials, which include oligomers or monomers, initiator, inhibitor, cross-linking agents, and intrinsic pigments. Extrinsic pigments, which are derived from human diet and lifestyle, attach to and penetrate the base resin to cause color changes.[2]

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When the external surface of dental restoration is rough, more plaque forms, promoting tooth loss due to caries or periodontal disease as well as denture stomatitis. In recent studies, a threshold level of surface roughness (Ra=0.2 mm) has been indicated for plaque accumulation. Although no further reduction in plaque accumulation was expected for the smooth surfaces below this borderline level, higher surface roughness resulted in a simultaneous increase in plaque accumulation. Furthermore, dental restorations with rough surfaces are more prone to staining and discoloration, leading to reduced esthetics and acceptability of the restoration.[3]

Color stability and stain resistance criteria may provide important information on the serviceability of these materials. Most resin-based materials used for prosthetic treatment are prone to absorption and adsorption of liquids, thus staining may produce color changes during service in the oral environment. Prosthesis staining due to colorants in a service environment may be more largely responsible for color change than color instability of the material itself.[4]

Traditionally, denture base materials were mechanically pre-polished in a dental laboratory by using water and fine pumice. In that method, fine polishing is carried out using polishing pastes or aluminum oxide particles containing liquid polish.[5] This causes surface defects and roughness.

So the color and surface roughness are important factors in maintaining for long-term use of the prosthesis.

2. Materials and Methods

2.1. Preparation of the specimens and testing

Metallic discs of diameter 50+/- 1 mm and 0.5 +/- 0.05 mm thick (according to ADA specification No 12) were invested in a denture flask using dental stone to prepare a mold space. The denture base polymer and monomer were mixed in the ratio of 3:1 by volume and processed to for disc shaped specimen. All the samples were finished, polished and checked for surface roughness. Sealants were applied on denture base material and cured using light curing unit. All the 120 samples were divided into

Group I – Lucitone 199 and Optiglaze, 60 samples

Group II – Lucitone 199 and Easyglaze, 60 samples

All the specimens were immersed in solution of coffee, tea and distilled water and were divided into further subgroups as follows

Group IA - Lucitone 199, Optiglaze and coffee, 20 samples

Group IB - Lucitone 199, Optiglaze and tea, 20 samples

Group IC - Lucitone 199, Optiglaze and distilled water, 20 samples

Group IIA - Lucitone 199, Easy Glaze and coffee, 20 samples

Group IIB – Lucitone 199, Easy Glaze and tea, 20 samples

Group IIC - Lucitone 199, Easy Glaze and distilled water, 20 samples

The specimens were checked for a surface rough, color stability for a week, one month, two months, three months and four months. Samples were checked for surface roughness using profilometer and color changes spectroptometer.

2.2. Statistical analysis

Descriptive and inferential statistical analysis is carried out in the present study. Results on continuous measurements were presented on Mean and SD and results on categorical measurement were presented in number (%). Level of the level significance was fixed at p=0.05 and any value less than or equal to 0.05 was considered to be statistically significant.

Student t test was used to find the significance of study parameters on continuous scale between two groups (Intergroup analysis). One-way Analysis of variance (ANOVA) was used to find the significance of study parameters within the groups. Further post hoc analysis was carried out if the values of ANOVA test were significant.

Repeated measures Analysis of variance was used to find the significance of study parameters within the group at different time intervals. Further Bonferroni's post hoc analysis was carried out if the values of the RM-ANOVA test were significant.

The Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA) was used for the analyses of the data and Microsoft word and Excel were used to generate graphs, tables etc.

3. Results

Application of optiglaze as surface sealant had resulted in mean surface roughness value of 0.08 for one week, 0.093 for one month, 0.101 for two months, 0.0895 for three months, 0.073 for four months in coffee samples. Similarly for tea samples mean surface roughness was found to be 0.0775 for one week, 0.102 for one month, 0.1075 for two months, 0.082 for three months, 0.0725 for four months. For water it was found to be 0.1325 for one week, 0.119 for one month, 0.1166 for three months, 0.05335 for three months, 0.057 for four months. For Easy Glaze surface sealant had mean surface roughness values of 0.1055 for one week, 0.1055 for one month, 0.068 for two months, 0.065 for three months, 0.0385 for four months for coffee. Similarly for tea it was 0.0715 for one week, 0.0565 for one month, 0.0735 for three months, 0.0475 for three months, 0.0295 for four months. For water it was 0.0465 for one week, 0.061 for one month, 0.076 for two months, 0.0445 for three months and 0.0245 for four months which shows that all the values are significant and that optiglaze has better efficiency than easyglaze surface seleant overall surface roughness

decreased over the period of time.

3.1. Intergroup comparison (Figures 1 and 2)

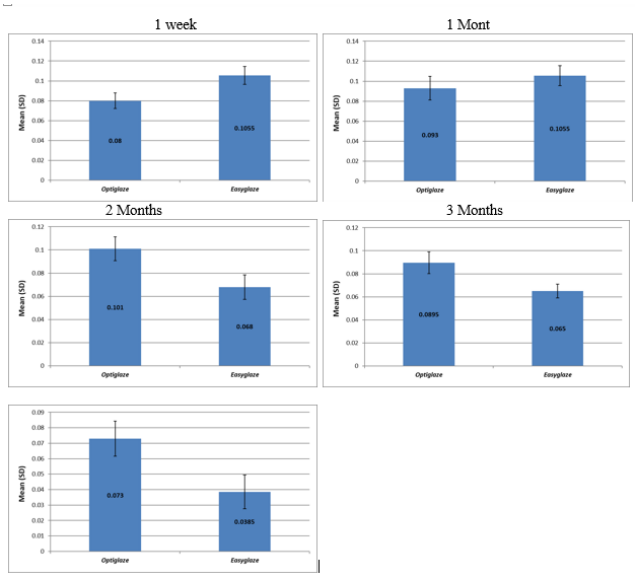

Fig. 1: Comparison of the surface roughness values in terms of {Mean (SD)} for coffee group at different time intervals among Optiglaze and Easy glaze using unpaired t test

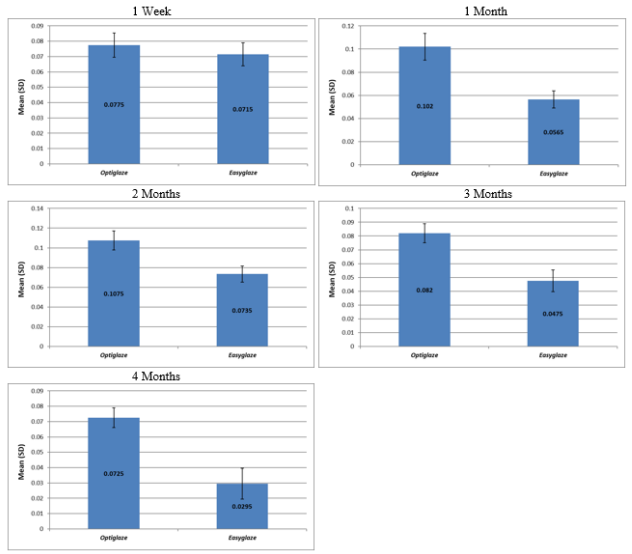

Fig. 2: Comparison of the surface roughness values in terms of {Mean (SD)} for tea group at different time intervals among Optiglaze and Easy glaze using unpaired t test.

3.2. Intergroup comparison (Figures 3, 4 and 5)

Delta E values for samples coated with optiglaze and immersed in coffee for 1week were 6.73, 1 month were 5.98,

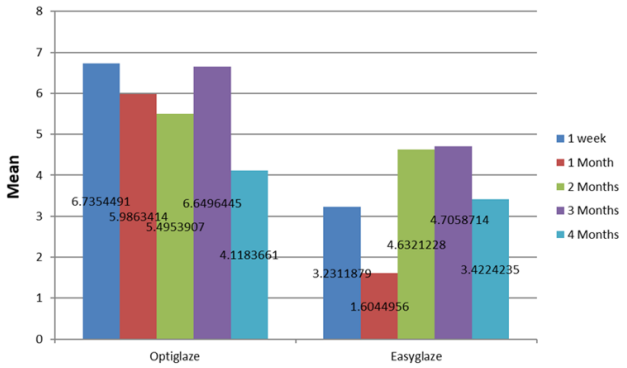

Fig. 3: Comparison of the color stability values in terms of {Mean (SD)} for coffee group at different time intervals among Optiglaze and Easy glaze using unpaired t test.

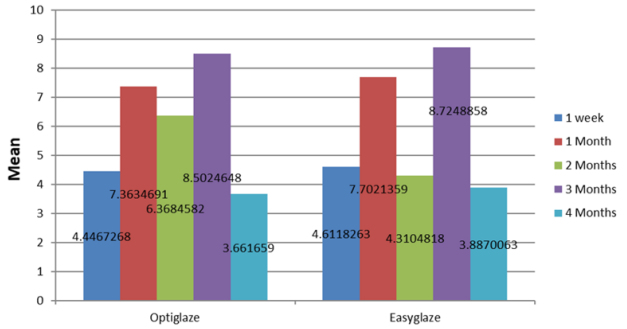

Fig. 4: Comparison of the color stability values in terms of {Mean (SD)} for tea group at different time intervals among Optiglaze and Easy glaze using unpaired t test.

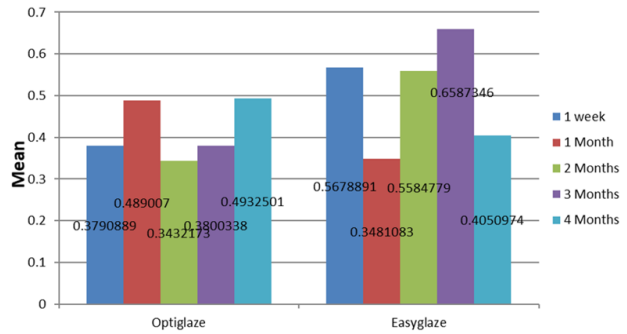

Fig. 5: Comparison of the color stability values in terms of {Mean (SD)} for distilled water group at different time intervals among Optiglaze and Easyglaze using unpaired t test

2 months were 5.49, 3 months were 6.64, 4 months were 4.11. For samples coated with easy glaze and immersed in coffee for 1 week was 3.23, 1 month was 1.604, 2 months was 4.63, 3 months was 4.63, 4 months was 3.422. Delta E values of samples coated with optiglaze and immersed in tea for 1 week was 4.44, 1 month was 7.36, 2 months was 6.36, 3 months was 8.50, 4 month was 3.66. For samples coated with Easy Glaze and immersed in tea for 1 week was 4.611, 1 month was 7.70, 2 month was 4.31, 3 month was 8.72,4 month was 3.88. Delta E values for samples coated with optiglaze and immersed in water for 1 week was 0.37, 1 month was 0.48, 2months was 0.34, 3 months was 0.38, 4 months was 0.49. For samples coated with easy glaze and immersed in water for 1 week was 0.56, 1 month was 0.34, 2 months was 0.55, 3 months was 0.65, 4 months was 0.40. Samples immersed in tea stained more then coffee and optiglaze is better sealant then easy glaze for color stability.

4. Discussion

In the present study, Ra values were less than the 0.2-mm threshold level that Bollen et al indicated.[6] Previous studies have suggested the positive effects of surface sealant or glaze materials on surface roughness. Sealant agents fill the micro fissures and microdefects that form after finishing/polishing the material to which they are applied and thus improve the optical properties and surface roughness. However, they can lead to problems like low resistance to abrasion, weak retention to the underlying material, and poor surface quality resulting from uneven spreading that may be due to the high viscosity.[7] Surface sealant agent application may provide resistance to stain in these specimens by reducing surface irregularities and defects.[8]

Polyzois et al showed that tea had higher staining effects than coffee on resilient denture liners which is same as potential as current study. The similarity between these studies may be partly attributable to polar properties of the tested materials that affect both the affinity of a material to extrinsic stains and the diffusion of water molecules. In this study, the denture base material tended to be hydrophobic and exhibited the least water sorption, while copolyamide was the most hydrophilic with the largest water uptake in the storage period.[9] The results of this study are in similar to present study tea has highest potential to change in color over coffee.

Um and Ruyter et al reported that the yellow colorants of coffee were less polar than the yellow colorants of tea. Discoloration of resin-based veneering materials by tea was mainly due to surface adsorption of the colorants. Discoloration by coffee was due to adsorption and also to absorption of colorants by some investigated materials. Absorption and penetration of colorants into the organic phase of the resin-based materials are probably due to compatibility of the polymer phase with the yellow colorants of coffee. This may explain why silicone material presented the greatest discoloration when subjected to the coffee solution, whereas copolyamide demonstrated the severest color change when tested materials. Were exposed to the tea solution in this study. These findings also agree to a certain extent with the statement that hydrophobic materials are stained by hydrophobic solutions, and hydrophilic materials with high water absorption are stained by hydrophilic colorants in aqueous solutions.[10]

Contemporary methods for the measurement of denture resin color are mainly colorimetric, spectrophotometric, and digital photographic, with computer-aided analysis. The spectrometer used in this study can rapidly measure the chrominance and intensity of transmitted light reflected by the specimens, with high spatial resolution, accuracy, and reproducibility, and thus produces highly accurate measurements.[2]

The Ra values were higher than the 0.2 mm threshold level. This unexpected result may be explained by surface irregularities caused by the removal of unpolymerized or nonadhered surface particles. A film of incompletely polymerized layer occurs on the surface of composite resin materials when they are contact with oxygen in the air.[11] Because intraoral factors may easily remove this layer, surface defects such as microcracks may occur.[11–13] Additionally, the formation of air bubbles in the sealant material during its application by brushing may also cause surface irregularities and increase the Ra values.[11]

Although obtaining a precise relationship between surface roughness and staining is not usually possible, surface roughness has been shown to be the main reason for the adsorption of stains. The adsorption and absorption of a colorant onto/into the organic phase of resin materials and the high surface reactivity of poorly polymerized surfaces have also been blamed for staining.

5. Limitations

The present study has the following limitations:

1. Thickness of sealants applied is not specified.
2. Seleant leach out over period of time which is not considered (durability).
3. Nutritional habits, brushing, denture cleansers, and opposing restorations should be considered in future investigations.
4. Long term performance of the sealant agents on candida or bacterial adhesion, wear resistance, and optical properties compared with different laboratory and chairside polishing techniques.

6. Conclusions

Within the limitation of the present study we can conclude that:

1. Optiglaze is a better sealant compared to easyglaze with better properties like less surface roughness and colour stability of commercially available denture base materials.
2. All groups had surface roughness less than plaque accumulation threshold (0.20 μm). Optiglaze had better efficiency in reducing surface roughness compared to easyglaze.
3. Beverages had effect on colour stability of commercially available denture base materials after application of two different surface sealants. In which tea had more staining effect then coffee in the present study. Optiglaze had better color stability compared to easy glaze.

Further study is required to evaluate long term performance of sealants in oral environment.

7. Conflict of Interest

None.

8. Source of Funding

None.

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