Original Article

# Effect of Monopoly-coating Agent on the Surface Roughness of a Tissue Conditioner Subjected to Cleansing and Disinfection: A Contact Profilometric *In vitro* Study

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## Abstract

**Introduction:** Tissue conditioners are used to improve the health of the soft tissues of denture-bearing areas. However, leaching of plasticizers from tissue conditioners results in deterioration, which necessitates frequent replacement. The life of these liners varies, but it can be extended by the use of a coating material. **Aim:** To evaluate the surface roughness of a tissue conditioner with monopoly coating, subjected to denture cleanser and disinfectant. **Materials and Methods:** Sixty disk-shaped specimens of Visco-gel were made and divided into six groups of 10 each (control 1 [C1], control 2 [C2], control 3 [C3], group 1 [M1], group 2 [M2], and group 3 [M3]). Specimens of the control group were not coated with monopoly, while the specimens of the groups 1, 2, and 3 were coated with monopoly. Specimens of C1 and M1 were immersed in distilled water. Specimens of C2, C3, M2, and M3 were immersed into solution of denture cleanser for 8 h at room temperature and immersed in distilled water for the remainder of the 24-h period. C3 and M3 specimens were treated with disinfectant for 10 min before testing the surface roughness. The surface roughness was measured on 1st, 3rd, 5th, 7th, and 14th day, using a contact profilometer. Student's paired *t*-test was used to compare the mean Ra values within each group. In the present study, $P < 0.05$ was considered as the level of significance. **Results:** The mean surface roughness values of M1, M2, and M3 groups were less than C1, C2, and C3, respectively. Among all the groups, M1 showed the least surface roughness values. **Conclusion:** Monopoly-coating agent prevents the deterioration and reduces the surface roughness of the tissue conditioner.

**Keywords:** *Denture cleanser, deterioration, plasticizers, Visco-gel*

## Introduction

Tissue conditioners have been used in the management of abused tissues underlying ill-fitting dentures, for functional impressions, for temporary relining of ill-fitting dentures and immediate dentures, and for tissue conditioning during implant healing.[1,2] The viscoelastic properties after gelation of these materials influence the efficacy in the preceding applications because the viscoelastic properties suitable for each clinical application are different.[3] It is suggested that material suitable for conditioning abused tissues should be soft and elastic.

The properties of the tissue conditioners are affected by the moist environment of the oral cavity, where ethanol and ester plasticizer is leached into the saliva and water is absorbed by the polymeric phase of the gel, which causes the surface to become stiff and rough.[4-6] The increased porosity of the tissue conditioners can lead to plaque accumulation and *Candida albicans* colonization,[7] and the two methods to control plaque to prevent denture stomatitis include mechanical plaque control[8,9] and chemical plaque control.[9-13] Mechanical cleaning of the tissue conditioners may lead to surface damage.[14] A chemical soaking technique is primarily the method of choice for geriatric patients and for those with poor motor capacity.[15] Denture cleansers have been reported to cause a significant deterioration of tissue conditioners in a relatively short time.[16]

The longevity of tissue conditioner is short, from weeks to a month which necessitates frequent replacement.[17] Several surface-coating agents (monopoly, palaseal, and fluorinated copolymer) extend the life of a temporary soft denture liner because they maintain the resilient characteristics,



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keep it clean and smooth, and decrease the incidence of microbial growth;[18-22] however, the effect of monopoly coating on the surface roughness of a tissue conditioner subjected to the action of denture cleanser and disinfectant has not been documented.

In the present study, the surface roughness of a tissue conditioner was evaluated, using a contact profilometer, with and without monopoly coating and subjected to routine use of denture cleanser and disinfectant. Null hypothesis was considered in the present study.

## Materials and Methods

### Preparation of the specimens

A polypropylene mold of 3-mm thickness and 20-mm internal diameter was made, and the specimens were prepared by mixing a tissue conditioner (Visco-gel, De Trey/Dentsply, Weybridge, Surrey, UK), according to the manufacturer's instructions, for 30 s, and after 2 min, the Visco-gel was poured into the mold and was pressed with a glass slab for 2 h.[23] The specimens were removed and stored in a sterile glass jar having distilled water.

### Grouping of the specimens

Ra mean values obtained from the pilot study were taken as the variable for sample size calculation using OpenEpi. The value of α (Type I error) was 5% and β (power of study) was 80%.

Sixty disk-shaped specimens of Visco-gel were made and divided into six groups of 10 each (control 1 [C1], control 2 [C2], control 3 [C3], group 1 [M1], group 2 [M2], and group 3 [M3]). Specimens of C1, C2, and C3 were not coated with monopoly, while specimens of G1, G2, and G3 were coated with monopoly, three times on all surfaces, and each layer was allowed to dry for 3 min before recoating.[20]

Specimens of C1 and M1 were immersed in distilled water for 24 h. Specimens of C2, C3, M2, and M3 were immersed into solution of denture cleanser (Fitty Dent, Group Pharmaceuticals Ltd., Mumbai, India) for 8 h at room temperature, washed thoroughly with tap water, and immersed into distilled water for remaining 16 h. The preparation of fresh cleanser and immersion of specimens were continuously repeated for 14 days.[16] C3 and G3 specimens were treated with disinfectant (Hexidine, ICPA Health Products Ltd., India) for 10 min before testing the surface roughness.[24]

### Preparation of monopoly

Coating agent (monopoly) was prepared by mixing chemically activated methyl methacrylate monomer and clear methyl methacrylate polymer. The mixture was composed of one part powder to 10 parts liquid. The powder and liquid were placed together in a glass beaker in a water bath at 55°C and stirred for 8–10 min until the mixture started to thicken. The syrup-like liquid was then stored in a dark-colored bottle at 4°C to extend its shelf life and was applied to specimens of group M1, M2, and M3.[20]

The surface roughness of all the groups was measured on 1st, 3rd, 5th, 7th, and 14th day, since the reported loss of ester plasticizer ranged from 0.3 to 8.7 mg/g within 14 days[20] using a contact profilometer (Mitutoyo Surftest SJ-400) [Figure 1] and the method used was to scan a diamond stylus across the surface under a constant load and compute the numeric values representing the roughness of the profile as Ra. The Ra value describes the overall roughness of a surface and is defined as the arithmetic mean value of all absolute distances of the roughness profile from the center line within the measuring length.[25] Ra values were obtained with a traversing length of 30 mm and a cutoff length of 2.5 mm. According to the manufacturer's instruction, a diamond stylus of 5-μm tip radius was used under a constant measuring force of 3.9 mN. On each specimen, three passes were carried out, and the mean Ra of these three readings was used for the statistical analysis.

### Statistical analysis

In the present study, $P < 0.05$ was considered as the level of significance. Statistical Package for the Social Sciences (SPSS Inc., Chicago, USA) version 11 software was used for statistical analysis. Student's paired *t*-test was used to compare the mean Ra values within each group. The mean and standard deviation were estimated for each group and were compared between different groups using one-way ANOVA followed by Tukey's honestly significant difference procedure appropriately.

## Results

The surface roughness of the monopoly-coated tissue conditioner was less than noncoated tissue conditioner from day 1 to day 14 [Table 1]. The mean surface roughness value of M3 was significantly higher than the mean surface roughness values of M1 and M2 on all days ($P < 0.0001$).


**Figure 1: Contact profilometer**

Further, the mean surface roughness value of M2 was significantly higher than the mean surface roughness value of M1 on day 1, day 3, day 5, day 7, and day 14 [Table 2].

The mean surface roughness value of group C1 was significantly higher than mean surface roughness value of group M1 from day 1 to day 14 [Table 3]. The mean surface roughness value of group C2 was significantly higher than mean surface roughness value of Group M2 from day 1 to day 14 [Table 4]. The mean surface roughness value of group C3 was significantly higher than mean surface roughness value of group M3 from day 1 to day 14 [Table 5].

## Discussion

Statistically significant difference was found between the surface roughness values of all the groups; therefore, null hypothesis was rejected. The results of the study showed that the mean surface roughness values of all the specimens increased from day 1 to day 14 since the tissue conditioners are loosely structured plasticized gels that contain minimal, cross-linked, plasticized polymers. These plasticizers leach out resulting in surface alteration. Moreover, it has been reported that immersion in water significantly reduces the compliance of a tissue conditioner within the 1st week.[26] The mean surface roughness values of the specimens not coated with monopoly were significantly higher than that of specimens coated with monopoly. These results were in accordance with the findings of Gardner, who reported that longevity of tissue conditioner can be extended up to 1 year, by coating the tissue surface with monopoly, and that the monopoly coating maintains the resilient characteristics and keep the surface clean and smooth decreasing the incidence of microbial growth.[21]

The mean surface roughness value of group C1 was significantly higher than the mean surface roughness value of group M1 on all the days. These results indicate the surface deterioration of tissue conditioner due to leaching out of the low-molecular-weight plasticizer and ethyl alcohol from the material when immersed in water.[27] It was reported that most of the ethanol is lost during the first 24 h[20] and that the greatest loss occurs in the first 12 h and peaks at approximately 60 h.[27]

When mean surface roughness values of group C2 were compared with group M2, it was found that the value of group C2 was significantly higher than that of group M2. This increased value of group C2 is in accordance with the result of Nikawa *et al.*,[16,28] who reported that denture cleansers can cause increased deterioration of the surface as they cause loss of soluble components and plasticizers or absorption of water/saliva by the resilient-lining materials. Since the manufacture of the cleanser recommended the mixing of cleanser with warm water, the temperature of the water to be mixed with the cleanser was standardized at 37.7°C. The use of warm water in combination with a cleanser might have caused a more rapid surface deterioration.[10] Moreover; the increased surface roughness can also be due to alkaline peroxide denture cleanser.[28,29]

When C3 was compared with M3, it was found that the mean surface roughness value of group C3 was significantly higher than that of group M3; these results could again be due to the effect of monopoly-coating agents, which inhibit the leaching of plasticizers and maintain the surface, integrity even in the presence of the denture cleanser and disinfectant.

The marginal increase in the mean surface roughness values of the groups coated with monopoly may be due to minimal leaching out of the monomer from the monopoly[20] or due to exposure of the air bubbles that might have incorporated during mixing.[19]

In the present study, the surface roughness of the specimens of all the groups was greater than 0.76 μm, indicating that there is a possibility for plaque accumulation, since 0.2 μm is considered the threshold below which no further bacterial adherence can occur.[30] However, the surface roughness of the control group (1.29 μm–15.55 μm) was more than the surface roughness of the test group (0.75 μm–6.08 μm), which indicates that the surfaces of control group are more susceptible to bacterial colonization. The relatively smooth surface of the test group could be attributed to the presence

**Table 1: Comparison between different groups on the basis of Ra values**

| Day | ANOVA | Sum of squares | df | Mean square | *F* | *P* |
|---|---|---|---|---|---|---|
| Day-1 | Between groups | 38.612 | 5 | 7.722 | 143.800 | 0.001* |
| | Within groups | 2.900 | 54 | 0.054 | | |
| Day-3 | Between groups | 72.754 | 5 | 14.551 | 72.348 | 0.001* |
| | Within groups | 10.861 | 54 | 0.201 | | |
| Day-5 | Between groups | 72.754 | 5 | 14.551 | 72.348 | 0.001* |
| | Within groups | 10.861 | 54 | 0.201 | | |
| Day-7 | Between groups | 298.298 | 5 | 59.660 | 2087.799 | 0.001* |
| | Within groups | 1.543 | 54 | 0.029 | | |
| Day-14 | Between groups | 1182.285 | 5 | 236.457 | 517.679 | 0.001* |
| | Within groups | 24.665 | 54 | 0.457 | | |

Test applied: One-way ANOVA test; *$P \leq 0.001$ (highly significant)

**Table 2: Comparison of mean values between different study groups (test group)**

| Variable | Group | Mean±SD | *P* | Significance group at 5% level |
|---|---|---|---|---|
| Day-1 | M1 | 0.75±0.09 | <0.0001 | M3 versus M1, M2 |
| | M2 | 0.83±0.06 | | |
| | M3 | 1.11±0.13 | | |
| Day-3 | M1 | 1.15±0.10 | <0.0001 | M3 versus M1, M2, M2 versus M1 |
| | M2 | 1.48±0.12 | | |
| | M3 | 1.71±0.11 | | |
| Day-5 | M1 | 1.42±0.10 | <0.0001 | M3 versus M1, M2, M2 versus M1 |
| | M2 | 1.83±0.17 | | |
| | M3 | 2.17±0.22 | | |
| Day-7 | M1 | 1.95±0.13 | <0.0001 | M3 versus M1, M2, M2 versus M1 |
| | M2 | 2.25±0.13 | | |
| | M3 | 2.88±0.10 | | |
| Day-14 | M1 | 3.11±0.13 | <0.0001 | M3 versus M1, M2, M2 versus M1 |
| | M2 | 4.07±0.15 | | |
| | M3 | 6.08±0.11 | | |

Students paired *t*-test was used to compare the mean Ra values. SD: Standard deviation

**Table 3: Mean, standard deviation, and test of significance of mean values between Group C1 and M1**

| Variable | Mean±SD | | *P* |
|---|---|---|---|
| | Group C1 | Group - M1 | |
| Day-1 | 1.29±0.23 | 0.75±0.09 | <0.0001 |
| Day-3 | 2.44±0.68 | 1.15±0.10 | <0.0001 |
| Day-5 | 3.12±0.35 | 1.42±0.10 | <0.0001 |
| Day-7 | 4.04±0.18 | 1.95±0.13 | <0.0001 |
| Day-14 | 9.23±0.37 | 3.11±0.13 | <0.0001 |

One-way ANOVA followed by Tukey's HSD procedure. SD: Standard deviation, HSD: Honestly significant difference

**Table 4: Mean, standard deviation, and test of significance of mean values between Groups C2 and M2**

| Variable | Mean±SD | | *P* |
|---|---|---|---|
| | Group C2 | Group - M2 | |
| Day-1 | 2.11±0.12 | 0.83±0.06 | <0.0001 |
| Day-3 | 3.32±0.56 | 1.48±0.12 | <0.0001 |
| Day-5 | 4.77±0.33 | 1.83±0.17 | <0.0001 |
| Day-7 | 6.12±0.23 | 2.25±0.13 | <0.0001 |
| Day-14 | 13.01±0.17 | 4.07±0.15 | <0.0001 |

One-way ANOVA followed by Tukey's HSD procedure. HSD: Honestly significant difference; SD: Standard deviation

**Table 5: Mean, standard deviation, and test of significance of mean values between Groups C3 and M3**

| Variable | Mean±SD | | *P* |
|---|---|---|---|
| | Group C3 | Group - M3 | |
| Day-1 | 3.01±0.48 | 1.11±0.13 | <0.0001 |
| Day-3 | 4.28±0.63 | 1.71±0.11 | <0.0001 |
| Day-5 | 6.22±0.42 | 2.17±0.22 | <0.0001 |
| Day-7 | 8.15±0.21 | 2.88±0.10 | <0.0001 |
| Day-14 | 15.55±0.36 | 6.08±0.11 | <0.0001 |

One-way ANOVA followed by Tukey's HSD procedure. HSD: Honestly significant difference; SD: Standard deviation

of the coating agent despite the action of the cleanser and disinfectant.

### Limitations of the study

The surface roughness of a tissue conditioner *in vivo* may vary due to a variety of reasons such as effect of saliva, tissue surface irregularities, temperature changes, and masticatory forces. Thus, it should be noted that changes in surface roughness of the materials over time may be clinically different from those obtained in the present study. Hence, clinical simulation may be necessary to get more predictable results. In the present study, the surface of the tissue conditioner was subjected to the pressure from the glass slab during polymerization, while allowing polymerization to occur intraorally against the resilient mucosa might have provided a better simulation of the mucosa. The use of artificial saliva would have simulated a more physiological environment. Since only one group tissue conditioner was tested, conclusions derived from this study may not be applicable to other tissue conditioners.

## Conclusions

The mean surface roughness values of groups M1, M2, and M3 was less compared to C1, C2, and C3, respectively. This decrease in surface roughness of the test group compared to that of the control group could be attributed to the surface-coating agent in the test groups, resulting in a relatively smooth surface preventing adherence of microorganisms and plaque, thereby improving the hygiene of the prosthesis and health of the mucosa. Coating agents extend the longevity of the prosthesis, reduce the frequency of visits, and allow the clinician greater use of available resources.

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### Conflicts of interest

There are no conflicts of interest.

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