

Study of the effect of surface treatment on the long term effectiveness of tissue conditioner

Kamleshwar Singh, Pooran Chand, Balendra P. Singh and Chandra B. S. Patel

Department of Prosthodontics, Faculty of Dental Sciences, C. S. M. Medical University, Lucknow, India

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Abstract: Adequate softness and surface integrity are the two most important clinical features of a tissue conditioner. This study was designed to examine the effect of coating on the surface integrity and softness of a tissue conditioner at various time intervals. A total of 72 specimens were prepared and divided into two equal groups. Group I (control group) specimens were lined with tissue conditioner and left uncoated. Group II (test group) specimens were lined with tissue conditioner and coated with a surface conditioning agent. The specimens were then examined for softness with a durometer and for surface integrity with a scanning electron microscope (SEM) at the baseline, and after 1, 2 and 3 weeks. At 3 weeks, softness on the American Standards for Testing Materials (ASTM) scale showed a significant ($P < 0.001$) difference between the control and test groups. Qualitatively, SEM analysis indicated that surface integrity in the control group had deteriorated by the end of the first week, whereas that in the test group remained intact until the end of the third week. Within the limitations of this study, our data suggest that application of a coating can significantly reduce the loss of softness and surface integrity of a tissue conditioner. (J Oral Sci, 261-265, 2010)

Keywords: tissue conditioner; durometer; SEM; ASTM.

Correspondence to Dr. Kamleshwar Singh, Flat No. 502, Teachers Apartment, T. G. Campus, Lucknow, Uttar Pradesh Pin-226003, India

Tel: +91-923-6678094

Fax : +91-522-2257245

Email: dr_kamleshwarsingh@yahoo.co.in

Introduction

The use of tissue conditioning material has been found to be clinically effective for the management of damaged tissue underlying ill-fitting dentures, functional impressions, and temporary relining of ill-fitting dentures, and also for maxillofacial prostheses and immediate dentures (1-5). Tissue conditioners are soft, resilient materials used for treating inflamed, irritated, or distorted tissues, and for recording functional impressions. They are also used as interim reliners and during the healing phase after implant placement (6). Tissue conditioners are provided mostly as a powder and liquid system, but preformed sheets of acrylic gel are also available. The powder contains a polymer, polyethylmethacrylate, or its co-polymer, and the liquid contains a mixture of ethyl alcohol and an aromatic ester which acts as a plasticizer. The temporary nature of a tissue conditioner stems from the fact that both the alcohol and the plasticizer leach out and are partially replaced by water (7,8). The material thus hardens within a considerably short time, which varies from a few days to a week, and gradually loses its cushioning effect. This leads to increasing vulnerability, deterioration, contamination, and creation of a foul odor by micro-organisms, which in turn can lead to further irritation of the already damaged mucosal tissues.

Gardner and Parr (9) have reported extending the long term effectiveness of temporary soft liners (Soft Oryl, Teledyne Getz, Elk Grove Village, IL, USA) with Monopoly, a polymethyl methacrylate resin coating, for up to 1 year. The coating remained clean and smooth, with a reduced incidence of bacterial and fungal growth. The same authors also reported the effect of Monopoly painted on an acrylic resin nasal obturator to achieve a smooth polished surface (10). Casey and Scheer (11) compared the effects of surface

treatments with polyethyl methacrylate monomer, Monopoly glaze, and minute-stain glaze on tissue conditioner (Coe-Soft, Coe Laboratories Inc., Chicago, IL, USA) and found that use of Monopoly resulted in an improved glassy surface that lasted for 30 days intraorally.

Dominguez et al. (12) found that although tissue conditioner coated with Monopoly appeared to lose alcohol, it did not absorb water *in vitro*. In addition, there was no loss of plasticizer over the 30-day test period. Gronet et al. (13) evaluated whether surface coating of tissue conditioners with Palaseal (Heraeus Kulzer, South Bend, IN, USA) or Monopoly would improve their resiliency. They found a significant increase in the resiliency of Lynal (LD Caulk, Dentsply International, Milford, DE, USA) specimens coated with Palaseal and Monopoly and Visco-gel (DeTrey/Dentsply, Weybridge, UK) specimens coated with Palaseal. However, no difference between uncoated and coated specimens of Coe-Soft was demonstrated.

Hayakawa et al. (14) found that the fluorinated copolymer coating Kreguard (Kureha, Tokyo, Japan) imparted an improved glossy surface to a tissue conditioner, thus possibly increasing its useful life. Nimmo et al. (15) found that vacuum-treated Visco-gel produced a denser, less porous mix and improved the surface texture. However, microbial adhesion was not affected by vacuum treatment.

Corwin and Saunders (16) suggested a modified polymerization technique (intraoral curing for 10-15 min, followed by autoclaving with water at 43-46°C for 20-30 min at 25-30 psi) that would extend the useful clinical life of Lynal soft liner (LD Caulk, Dentsply International). Malmström et al. (17) reported the effect of two different coatings on the surface integrity and softness of a tissue conditioner (Coe-Comfort, GC America Inc., Alsip, IL, USA) and concluded that coating significantly reduced the loss of softness and surface integrity of the conditioner.

A currently available tissue conditioner (Visco-gel) satisfies most normal requirements, but needs to be replaced at short intervals, which is time-consuming and costly for both the dentist and the patient. Therefore, there is a need to improve the working life of these materials. Considering that two of the most important features of a tissue conditioner are adequate softness and surface integrity, the present study was designed to evaluate the effect of surface treatment on these parameters for the tissue conditioner, Visco-gel.

Materials and Methods

Preparation of resin disks: Disks of the heat-cured resin (Dentsply DeTrey GmbH, Germany) were prepared at a powder-liquid ratio of 2.5:1 by weight. The resin disks were prepared by investing a 2-mm-thick brass spacer of the same

thickness but of a different shape i.e. circular and triangular, to allow differentiation between the control (Group I) and the tested (Group II) samples. The heat-cured resin was mixed, packed into the mold with the brass spacer, and processed in a water bath at 74°C for 8 h.

Group I: Denture-based resin disks were circular with a diameter of 1 cm and thickness of 2 mm, lined with tissue conditioner and left uncoated (Control group).

Group II: Denture-based resin disks were triangular with a diameter of 1 cm and thickness of 2 mm, lined with tissue conditioner and coated with the surface conditioning agent (Test group).

Tissue conditioner: Visco-gel (Dentsply DeTrey GmbH, Konstanz, Germany) was selected as the tissue conditioner. It was prepared by mixing at a powder-liquid ratio of 3 g and 2.2 ml for 30 s. Resin disks in both groups were lined by Visco-gel. The resin disk and brass spacer of specified shape were invested in hard but flexible silicone rubber (Zetalabor; Zhermack, Rovigo, Italy) to allow ease of removal of the processed disks from the flask. Resin disks and brass spacers were machined to the same dimensions to standardize their shape and thickness. The resin disks were returned to the mold, and the Visco-gel was then packed into the space created by the brass spacer. After polymerization, the specimens were removed from the flask, and any flash was removed with a sharp knife (18).

Surface conditioning agent (coating): This was used for coating the tissue conditioner. It was prepared by mixing 1 part of clear acrylic resin polymer by weight to 10 parts of heat-cured acrylic resin monomer. The monomer was poured into a Pyrex beaker and placed in a pan of water at 54°C. When the monomer was warm, the polymer was allowed to mix slowly with the monomer while stirring continuously with a glass rod. After 10 min, the solution became viscous. It was then cooled to room temperature, poured into a dark glass bottle, and refrigerated (19). The Group II specimens were coated with the surface conditioning agent. The specimen was dried in air, and the coating was applied to the specimen surface using a good-quality brush. The agent was then allowed to dry for 4 to 5 min under a lamp with a 60-W bulb located approximately 2 inch from the surface of the specimen. This procedure was repeated until three coats had been applied and dried (9).

Artificial saliva: Artificial saliva prepared using the method of Katz (20) was used for *in vitro* study.

Durometer: A durometer, which has been reported to be an appropriate tool for measurement of softness, was used to evaluate the softness of the tissue conditioner. The durometer (Model 411, ASTM Type OO; PTC Instruments, Los Angeles, CA, USA), had a mainspring with a load force

of 113 gf, an indenter with a 3/32 inch hemispherical tip, an accuracy of ± 2.5 gf, and a measurement range of 0 to 100 points on the American Standards For Testing Materials (ASTM) scale. A lower score on the scale indicates greater softness (17).

Scanning electron microscopy (SEM): Changes in the surface integrity of the tissue conditioner were analyzed by SEM (LEO 430, Zeiss Leica, UK) (17).

Test procedure (methods):

- (a) Test procedure for softness: The specimens in both groups, after immersion in artificial saliva at room temperature for various periods, were tested for softness with the durometer. The readings were measured on the ASTM scale of durometer.
- (b) Test procedure for surface integrity: The specimens in both groups, after immersion in artificial saliva for various periods, were taken and air-dried for 30 min. Each dried specimen was then mounted on an aluminum stub with an electroconductive material. The mounted specimen was then transferred to a sputter-coater for coating with gold. The specimen was then removed and placed in the rotating platform chamber of the SEM for evaluation of surface integrity.

Comparisons were made by analysis of variance. Individual paired comparisons were made using Student's *t*-test, and differences were considered statistically significant at $P < 0.001$.

Results

The specimens in both groups were tested with the durometer after immersion in artificial saliva at room temperature for various intervals. Table 1 shows the mean surface softness scores after different time intervals. At the baseline, the mean surface softness scores in Groups I and II were 64.87 ± 0.83 and 61.87 ± 0.83 , respectively, and the difference was statistically significant ($P < 0.001$).

At the end of the first week, the mean surface softness scores in Groups I and II were 69.00 ± 0.76 and 64.63 ± 1.92 , respectively. The mean softness score in Group I was significantly higher ($P < 0.001$) than that in Group II.

At the end of the second week, the mean surface softness scores in Groups I and II were 73.88 ± 0.83 and 67.00 ± 0.76 , respectively, that in Group I again being significantly higher ($P < 0.001$). At the end of the third week, the mean surface softness scores in Groups I and II were 78.88 ± 0.83 and 69.13 ± 0.83 , respectively, again being significantly higher ($P < 0.001$) in Group I. Thus, at each of the determined time points, the mean softness score in Group II was significantly ($P < 0.001$) lower than that in Group I, i.e. the Group II specimens were softer.

The surface integrity of the specimens in both groups was also studied by SEM after immersion in artificial saliva at room temperature for various intervals. SEM analysis indicated that the surface integrity of the specimens in Group I deteriorated with time, whereas that in Group II remained intact up to the end of the third week (Fig. 1).

SEM analysis of Group I showed that the surface integrity of the control specimens deteriorated with time. At the baseline, the surface was generally free of irregularities. However, at the end of the first week, the tissue conditioner had begun to show bead formation due to alcohol, which acts as a catalyst and disintegrates the liner. At the end of

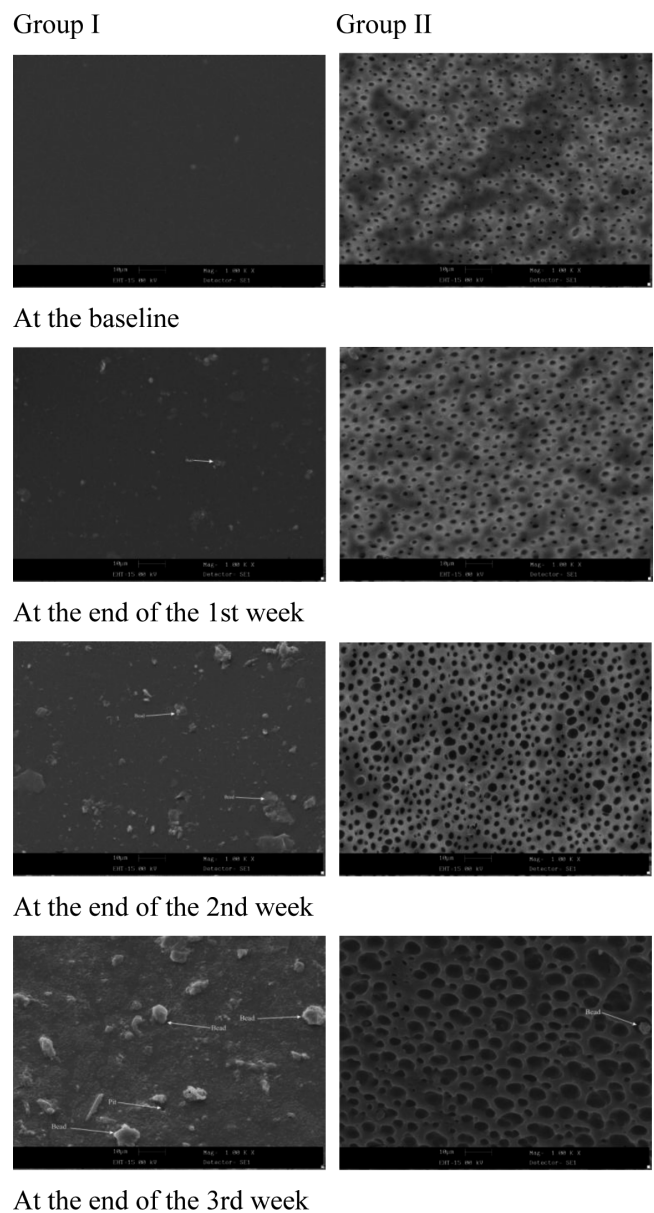


Fig. 1 Comparative SEM observations of progressive deterioration in the surface integrity of specimens in Groups I and II.

the second week, the surface of the tissue conditioner showed further disintegration with an increase in the number and size of the beads. At the end of the third week, the surface of the tissue conditioner had completely disintegrated, with many beads and pits being evident.

SEM analysis of Group II indicated that the surface integrity of the specimens remained intact up to the end of the third week. At the baseline, the entire surface of the tissue conditioner was covered by a uniform layer of surface conditioning agent. At the end of the second week, the surface still remained free of beads, indicating that alcohol had not leached out due to the integrity of the surface conditioning coat. At the end of the third week, there was continuity of the coated layer with some increase of bead formation, as was reported in a previous SEM study (11,17).

Discussion

Currently available tissue conditioners satisfy most clinical requirements, but their properties are still less than ideal. In particular, softness and surface integrity are of great concern in clinical practice. The most commonly used tissue conditioners are plasticized acrylic resins. These resins may be heat- or chemically activated. Chemically activated tissue conditioners generally employ poly (methylmethacrylate) or poly (ethyl methacrylate) as their principal structural components. These polymers are supplied in powder form and are subsequently mixed with liquids containing ethanol and plasticizer. The plasticizer is usually a large molecular species such as dibutylphthalate. The distribution of large plasticizer molecules minimizes entanglement of polymer chains and thereby permits individual chains to "slip" past one another. This slipping motion permits rapid changes in the shape of the tissue conditioner and provides a cushioning effect for the underlying tissues. The liquids used in such applications

do not contain acrylic monomers. Consequently, the resulting liners are considered short-term soft liners or tissue conditioners. Unlike chemically activated soft liners, heat-activated materials are generally more durable and may be considered long-term soft liners. The powders are composed of acrylic resin polymers and copolymers, whereas the liquids consist of appropriate acrylic monomers and plasticizers (21).

Both the alcohol and plasticizers of soft liners leach out and are partially replaced by water. The material thus hardens within a considerably short time, and gradually loses its surface integrity and cushioning effect (22). The results of the present study support other investigations that have indicated that tissue conditioners with a coating may have fewer surface irregularities (9,11,17).

Table 1 shows that there was a significant ($P < 0.001$) and regular increase in the mean softness score after increasing periods of immersion in artificial saliva. However, because of the use of the conditioning agent in Group II, the degree of change in the softness was only about half of that in Group I. The surface-coated tissue conditioner retained its softness longer, perhaps due to a reduction in the rate of leaching of the plasticizer, as well as the penetrant (alcohol). It is also possible that surface-coated tissue conditioners prevent the absorption of salivary inorganic salts, which may be a contributing factor to the hardening process (23).

One limitation of this and similar studies is that currently, the level of softness or surface integrity necessary for a tissue conditioner to be regarded as clinically effective is unknown. Several investigators have suggested that 2 mm is an appropriate thickness for a tissue conditioner (1,24). Yoeli et al. (25) reported that the thickness of a tissue conditioner has a significant effect on measured softness, a thicker tissue conditioner being softer. Another limitation of this study was that only one brand of tissue conditioner

Table 1 Comparison of mean softness in the two groups at different time points after immersion in artificial saliva

S. No.	Time Interval	Softness (Mean \pm SD)		<i>t</i>	<i>P</i>
		Group I (<i>n</i> = 8)	Group II (<i>n</i> = 8)		
1.	At the baseline	64.87 \pm 0.83	61.87 \pm 0.83	7.19	< 0.001
2.	At the end of 1st week	69.00 \pm 0.76	64.63 \pm 1.92	5.99	< 0.001
3.	At the end of 2nd week	73.88 \pm 0.83	67.00 \pm 0.76	17.27	< 0.001
4.	At the end of 3rd week	78.88 \pm 0.83	69.13 \pm 0.83	23.37	< 0.001

was used. Therefore, the results may not be applicable to other tissue conditioners treated with the same coatings.

Thus, preserving the softness and surface integrity of a tissue conditioner by coating may prolong its working life. The present results suggest that surface coating may allow a tissue conditioner to function longer than is currently recommended by the manufacturer before it needs to be replaced.

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