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Original article

# The influence of patient characteristics on acrylic-based resilient denture liners embedded in maxillary complete dentures

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ABSTRACT

*Purpose:* A major complication associated with the use of resilient denture liners (RDLs) is a change in hardness over time. *In vivo* studies on the deterioration of RDLs over time are needed. We aimed to investigate the influence of patient characteristics on the hardness of acrylic-based RDLs (ARDLs) embedded in complete maxillary dentures. We hypothesized that 1 month after application of the ARDLs, the hardness would be influenced by age, saliva condition, occlusal force, smoking, drinking, denture wearing during sleeping, denture cleanser usage, and denture type.

*Methods:* Thirty complete maxillary denture wearers were recruited after obtaining informed consent. One investigator measured the Shore D hardness of the commercially available ARDLs, Soften (SFT), FD Soft (FDS), and Bio Liner (BIO) using a Vesmeter®. The salivary flow rates and pH values and the occlusal force were measured for all patients before initiation of the study. *T*-tests and Pearson's correlation coefficients were used for the statistical analyses. A $p$-value of $<0.05$ was considered statistically significant.

*Results:* Smoking, wearing dentures while sleeping, use of denture cleansers, and denture type were associated with an increase in the hardness of the RDLs. The resting saliva pH only influenced the hardness of the SFT ARDLs.

*Conclusions:* Smoking, denture wearing while sleeping, denture cleanser usage, denture type, and resting saliva pH are important predictors of the deterioration of ARDLs over time.



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## 1. Introduction

Resilient denture liners are used by denture wearers, particularly wearers of complete mandibular dentures who have thin mucosa with advancing alveolar bone resorption and cannot wear conventional hard acrylic dentures due to pain caused by occlusal force. It has been reported that the application of resilient denture liners (RDLs) to mandibular dentures improves masticatory function and creates greater maximum biting force, without causing an adverse effect on the muscular activity [1,2], resulting in an improvement in the patients' satisfaction rating [3,4]. These clinical effects of RDLs are derived from their viscoelastic properties.

Therefore, durability is a particularly important factor when RDLs are applied to dentures. It is highly desirable to maintain the original properties of RDLs within the mouth; however, RDLs deteriorate with time in a clinical setting [5]. One major problem observed in dentures with RDLs is a change in hardness over time. Specifically, the increase in hardness of RDLs worsens the distribution of the masticatory load and lowers the absorption of the elastic energy [6], resulting in increasing difficulty in wearing dentures for individuals who cannot wear conventional dentures based on a hard resin.

Researchers have studied how the hardness of RDLs changes using different study designs. In studies focusing on the long-term use of dentures in a clinical setting, specimens have been stored for 1 year in water at 37 °C [7,8]. To simulate the intraoral temperature change induced by food or beverage, specimens have been stored in water between 5 °C and 55 °C with a variety of cycling times [9–12]. The composition of the storage media in which the specimens were immersed has also been considered [13]. Considering daily clinical use, RDLs have been disinfected [14,15] or immersed in different beverages [16], and one study simulated pressure from the denture base [17]. Researchers have attempted to simulate all aspects of the oral environment resulting from the daily use of dentures in *in vitro* studies.

However, *in vitro* studies are limited in their ability to accurately simulate the oral environment and cannot fully represent real conditions. Therefore, the deterioration of RDLs may differ between *in vitro* conditions and the conditions encountered in denture wearers. We conducted an *in vivo* study to investigate how acrylic-based RDLs (ARDLs) changed in hardness when embedded in complete maxillary dentures worn by patients for 1 month in a clinical setting. We hypothesized that the hardness 1 month after application of the ARDLs would be affected by the age of patients, condition of the saliva, occlusal force, type of denture used, and habits related to smoking, drinking, wearing dentures while sleeping, and using a denture cleanser.

## 2. Materials and methods

### 2.1. Participants

This study was approved by the Human Ethics Committee of Nihon University School of Dentistry, Matsudo (EC 13-006). Thirty wearers of complete maxillary dentures (12 men; mean age, 71.8 ± 9.2 years and 18 women; mean age, 70.2 ± 10.7 years) who visited the Department of Removable Prosthodontics at our institute were recruited for this study. The volunteers were enrolled only after they provided written informed consent. Complete maxillary denture wearers who had been treated with a tissue conditioner, RDLs, and denture adhesives were excluded. All participants were instructed to wear their dentures as per their normal routine.

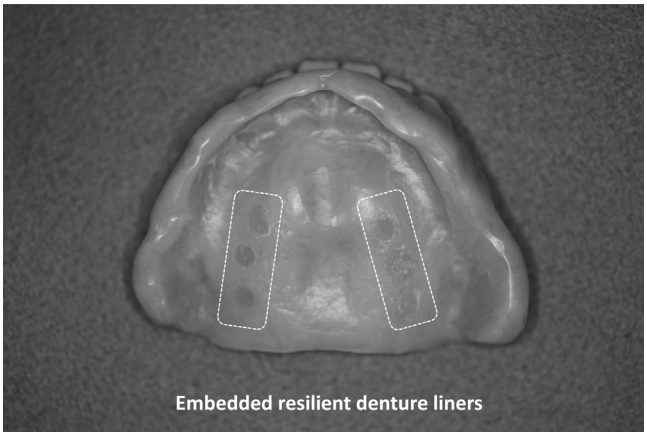


**Fig. 1 – RDL-embedded complete maxillary denture. Cylindrical RDLs with a 4-mm diameter and 2-mm depth were embedded in the complete maxillary denture.**

Before starting the clinical trial, the participants were asked about the following environmental factors in a questionnaire: smoking, drinking, denture wearing during sleeping, and denture cleanser usage.

### 2.2. Specimen preparation

A cylinder shape with a 4-mm diameter and 2-mm depth was drilled into the inner surface of the denture base. Then, the ARDL materials were mixed, packed into the cavity of the denture for specimen preparation (Fig. 1), and the denture was set in the proper position on the maxillary alveolar ridge under the occlusal pressure. After polymerized, the flash of the RDL was removed. The specimens in the denture contacted the oral mucosa. Table 1 shows the details of the three commercial ARDLs used in this study: Soften (SFT; KAMEMIZU CHEM, Osaka, Japan), FD Soft (FDS; KAMEMIZU CHEM, Osaka, Japan), and Bio Liner (BIO; Nissin Dental Products, Kyoto, Japan). Three acrylic and silicone-based RDLs were embedded in each maxillary denture. However, we will only report the results of the ARDL assessments in this paper.

### 2.3. Measurements

#### 2.3.1. Hardness

Hardness was measured using a Vesmeter® (WaveCyber Corp, Saitama, Japan). When the probe, which includes a built-in position sensor connected to a personal computer, was placed in a perpendicular orientation to an ARDL, the indenter of the probe was depressed onto the ARDL at a constant speed through electromagnetic power. Simultaneously, the path of the indenter was constantly traced by the position sensor. The computer processed electrical signals from the measuring

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