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### Original article

# Effectiveness of a combination denture-cleaning method versus a mechanical method: comparison of denture cleanliness, patient satisfaction, and oral health-related quality of life

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#### ABSTRACT

**Purpose:** Effective denture plaque control is necessary in elderly individuals to prevent oral and systemic diseases. However, comparative studies of denture cleaning methods are limited, especially those investigating patient satisfaction. The present study aimed to evaluate effectiveness of a mechanical denture cleaning method versus a combination of mechanical and chemical methods in terms of denture cleanliness, patient satisfaction, and oral health-related quality of life (OHRQoL).

**Methods:** Thirty edentulous participants were allocated to one of two groups: mechanical or combination method. The mechanical method group was instructed to brush dentures after each meal for 2 min using tap water and a denture brush, and to soak them in saline solution while sleeping. The combination method group was instructed to brush dentures the same way, but to soak them in denture cleansers while sleeping. Both groups cleaned their dentures according to the respective method for 3 weeks. Denture cleanliness, patient satisfaction, and OHRQoL were examined.

**Results:** There were significant differences in adenosine triphosphate bioluminescence ( $p=0.00003$ ), staining ( $p=0.003$ ), and *Candida albicans* (*C. albicans*) abundance in upper complete dentures ( $p=0.002$ ) between methods. There were no significant differences in oral mucosa *C. albicans* abundance, participant satisfaction, ease of cleaning, comfort, esthetics, or Oral Health Impact Profile for edentulous patients (Japanese version) scores between methods.

**Conclusions:** A combination of mechanical and chemical denture cleaning methods was more effective at cleaning dentures than the mechanical method alone. Even if denture cleaning improves denture hygiene, it may not increase patient satisfaction or OHRQoL.

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## 1. Introduction

Recently, it has been suggested that oral microorganisms are associated with systemic disease and that dentures represent a reservoir for these microorganisms [1–4]. Denture plaque is associated not only with oral disease, such as denture stomatitis, periodontitis, and caries, but also systemic disease, including aspiration pneumonia, gastrointestinal infection, and pleural infection. Therefore, effective denture plaque control is necessary to prevent these diseases, especially in an aging society [1–4].

There are three methods of denture cleaning: mechanical, chemical, and thermal. The mechanical method uses brushes and ultrasonic devices, the chemical method involves soaking the denture in cleansers, and the thermal method involves the use of microwave ovens [1,3,4]. A systematic review by de Souza et al. [3] reported that denture cleansers and brushing are more effective than placebo at reducing plaque coverage and microbial counts of anaerobes and aerobes on the complete denture base. However, these findings are not generalizable due to the wide range of different interventions and outcome variables.

An *in vitro* study by Paranhos et al. [5] demonstrated that a combination of mechanical and chemical methods was more effective at reducing microbial biofilms on acrylic resin specimens than the chemical method alone. An *in vivo* study by Dills et al. [6] showed that mechanical and chemical methods were more effective than no treatment for reducing plaque microorganisms,

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and a combination of mechanical and chemical methods was more effective than mechanical and chemical methods alone. It appears that mechanical or chemical methods alone may be insufficient for adequate denture cleaning, but a combination of the two is more effective [1–10].

There is limited information available regarding the evaluation of mechanical and chemical methods, and comparisons between the two, due to lack of standardized methods for examining the efficacy of denture cleaning methods [1,3,4]. Moreover, little is known about the effect of different methods on patient satisfaction and preferences, costs, adverse effects, and mucosa under the denture base [3,4]. Although dentists tend to objectively evaluate denture cleanliness, elderly patients often show little interest in the matter.

Recently, the adenosine triphosphate (ATP) bioluminescence method has increased in popularity for evaluating environmental cleanliness [11]. ATP is a basic source of energy for all living organisms. The ATP bioluminescence method measures the amount of ATP as an indication of contaminant level. It is used not only to evaluate public hygiene and cleanliness in hospitals, but also to assess oral hygiene, caries risk, and root canal bacteria [11–16]. Therefore, the ATP bioluminescence method can be applied in various situations as a simple and rapid inspection method; however, little is known about the appropriateness of this method for evaluating denture cleanliness.

In the present study, we initially evaluated the reliability and validity of ATP bioluminescence as an inspection method for denture cleanliness. We then evaluated the effectiveness of the mechanical denture cleaning method versus a combination of mechanical and chemical methods in terms of denture cleanliness, patient satisfaction, and oral health-related quality of life (OHRQoL). To the best of our knowledge, no previous study has investigated the effects of different denture cleaning methods on patient satisfaction [3]. The null hypothesis of this study was that there are no differences in denture cleanliness, patient satisfaction, and OHRQoL between the mechanical method, and a combination of mechanical and chemical methods.

## 2. Materials and methods

### 2.1. Pilot study

The reliability and validity of ATP bioluminescence as an inspection method of denture cleanliness was evaluated. To evaluate reliability, the upper complete dentures of five patients were assessed three times using the ATP bioluminescence method, and the interclass correlation coefficient was calculated. To evaluate validity, the upper complete denture of 12 patients was assessed using the ATP bioluminescence method, stained photograph method, and a simple quantification of *C. albicans* at initial patient hospital visit and after denture cleaning by dentists. The Spearman's rank-correlation coefficient between the ATP bioluminescence method and stained photograph method, and between the ATP bioluminescence method and simple quantification of *C. albicans*, was calculated.

The score of the correlation coefficients was judged in accordance with the guideline. This guideline expressed 0.0–0.20 as slight, 0.21–0.40 as fair, 0.41–0.60 as moderate, 0.61–0.80 as substantial, and 0.81–1.00 as almost perfect [17].

The intraclass correlation coefficient of the ATP bioluminescence method was 0.93, which indicates high reliability. The Spearman's rank-correlation coefficients between the ATP bioluminescence method and stained photograph method, and between the ATP bioluminescence method and simple quantification of *C. albicans*, were 0.63 ( $p=0.001$ ) and 0.52 ( $p=0.001$ ), respectively; this indicates acceptable validity.

### 2.2. Participants

A total of 33 edentulous individuals were assessed for eligibility in this study. The participants comprised patients who visited the Tokyo Medical and Dental University Hospital Faculty of Dentistry (Tokyo, Japan) for new fabrication, adjustment, or recall of complete dentures during 2016. All participants provided written informed consent and received an explanation of the study. Exclusion criteria included the following: serious systemic illness; difficulty with responding to the questionnaire; use of metallic base dentures; constant use of denture stabilizers; and use of dental tissue conditioner with dentures.

The sample size was based on information from a previous report. The primary outcome was measured according to the stained photograph method. This study reported that the mean and SD of the mechanical method are 39.53 and 22.56, respectively, and the mean and SD of the combination method are 18.40 and 16.11, respectively [10]. We calculated the sample size with a power of 80% at a 5% level of significance (two-tailed test), assuming a 20% dropout rate. The total sample size for the two groups was calculated to be 30 participants.

### 2.3. Study design

This study was a controlled, before-and-after trial involving two parallel groups. Thirty participants were randomly allocated to one of two groups ( $n=15$  each): mechanical method or combination method. Baseline data of the participants were examined and dentists were assigned to clean each denture by brushing for 1 min using a denture brush (Erac Gishi brush, Lion, Tokyo, Japan) and denture cleansers (Polident Fresh Cleanse, GlaxoSmithKline, Tokyo, Japan), followed by cleaning the dentures using ultrasonic vibration (SPEED SONIC 1510, Mortia, Tokyo, Japan) in a specific ultrasonic vibration denture cleanser (Denture Cleaner, GC, Tokyo, Japan), and then brushing them again in the same manner.

The specific method of denture cleaning was then explained to each group of study participants. Participants in the mechanical method group were instructed to brush their dentures after each meal for 2 min using tap water and a denture brush, and soak the dentures in saline solution (isotonic sodium chloride solution, Chemix Inc., Yokohama, Japan) while they slept. Individuals in the combination method group were instructed to brush the dentures the same way, but to soak them in denture cleansers (Polident<sup>®</sup>, GlaxoSmithKline) while they slept. Both groups were required to clean the dentures accordingly for 3 weeks. The study protocol was approved by the Tokyo Medical and Dental University (Ethics Committee of the Faculty of Dentistry, Tokyo Medical and Dental University, No. 1276).

### 2.4. Outcomes

For the objective evaluation of denture cleanliness, the ATP bioluminescence method, stained photograph method, and simple quantification of *C. albicans* in the upper complete denture and oral mucosa were performed. General participant satisfaction, ease of cleaning, comfort, and esthetics were measured using a 100 mm visual analog scale (VAS). OHRQoL was measured using the Japanese version of the Oral Health Impact Profile for edentulous patients (OHIP-EDENT-J). These parameters were examined immediately before the intervention and three weeks after the intervention.

#### 2.4.1. ATP bioluminescence method

The ATP bioluminescence method is based on a chemical reaction catalyzed by luciferase. The amount of light generated by this reaction, which is proportional to the amount of ATP present, is

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