A Clinical and Microbiological Evaluation of Denture Cleansers for Geriatric Patients in Long-Term Care Institutions

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Abstract

Background: *Many elderly patients in long-term care hospitals cannot adequately brush their dentures because of disease, dementia and poor dexterity. Such inadequate cleaning may allow for the multiplication of* Candida *spp. and bacteria, which could serve as reservoirs for disseminating infections.*

Objective: *To assess the efficacy of 3 denture cleansers in reducing the number of microorganisms on dentures in a hospitalized geriatric population.*

Methods: *Three brands of cleanser (Denture Brite, Polident and Efferdent) were compared; water was used as the control. Microbiological samples were obtained before and after 3 one-week periods of cleanser use; these samples were taken by a microbiologist blinded to the assigned treatment. In the statistical analysis, the ranks of the differences between the before-treatment and after-treatment scores of each regimen were compared by means of the general linear model. In addition, the efficacy of each cleanser in reducing accumulation of plaque, stain and food was assessed.*

Results: *The rank of the differences in the number of colony-forming units (CFUs) of* Candida *spp. before and after one week of use of Denture Brite (*p *= 0.04) and Polident (*p *= 0.01), was significantly greater than that of the control group, but there was no difference between Efferdent use and control (*p *= 0.10). No significant differences in reduction of* Streptococcus mutans *were observed between Denture Brite (*p *= 0.13) or Polident (*p *= 0.12) and the control group, whereas dentures cleaned with Efferdent exhibited significantly greater reduction in* Streptococcus mutans *(*p *= 0.02) than dentures cleaned with water. Over all study periods, there were no significant differences among the cleansers in reduction of* Candida *spp. or* Streptococcus mutans*. Dentures cleaned with Denture Brite, Polident or Efferdent appeared to have similar reductions in the level of plaque, stain and food, and all had substantially greater reductions than dentures cleaned with water only. The significant difference in the rank of the reduction in* Candida *spp. CFUs (*p *= 0.005) was related to the variance between study periods (*p *= 0.01) and the variance between subjects (*p *= 0.008).*

Clinical Significance: *The use of denture cleansers significantly reduced the number of microorganisms on dentures in a hospitalized geriatric population.*

MeSH Key Words: *dental plaque/prevention and control; denture cleansers/therapeutic use; denture, complete/microbiology*

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It is common knowledge that edentulous patients in long-term care hospitals cannot adequately brush or maintain their dentures because of disease, dementia and poor dexterity.[1-4] Studies have revealed that poor dental hygiene and *Candida albicans* infections are common among elderly denture wearers.[3,5] As well, nurses in institutions are already overburdened, which makes it difficult for them to care for their patients' dentures. Regardless of cleaning efforts by patients and staff, soft debris, bacterial plaque and dental calculus are often found on denture surfaces.[1,6]

The importance of clean dentures in such patients should not be underestimated. Dentures containing debris, tartar and stain cause irritation and subsequent tissue response. Food particles located between the denture and the gingiva or between the denture and the palate allow multiplication of *Candida* spp. and bacteria, which can cause denture stomatitis[1] and multiple papillomatosis of the palate.[3] These microorganisms may also serve as reservoirs for disseminated infections with gastrointestinal and pleuropulmonary involvement[7,8]; however, it was recently noted that periodontal disease did not significantly increase the risk of coronary artery disease.[9] *Candida* pneumonia has been reported in a non-immunosuppressed host.[10] Fungal or bacterial infections may cause subacute bacterial endocarditis in patients with artificial heart valves and pneumonia in patients with chronic obstructive pulmonary disease.[11]

Denture cleaning and plaque elimination are generally neglected in most long-term care institutions. Patients and their family members, management staff and nursing staff exhibited a lack of understanding of the oral hygiene needs of geriatric patients, especially those who wear dentures.[6] Information provided by the American Dental Hygienists' Association on the care and cleaning of dentures recognized the value of commercially prepared denture powder, paste or tablets.[12] Brushing alone is insufficient for controlling plaque on dentures.[13] It is thus extremely important that chemical denture cleansers be used as an adjunct for patients unable to properly care for their dentures and manage overall oral hygiene.[14]

Immersion-type chemical solutions for cleaning dentures may be divided into 2 major groups: denture cleansers and disinfectants. Commercial denture cleansers may be classified into the following groups according to their mode of action or their main component: alkaline hypochlorites, alkaline peroxides, neutral peroxides with enzymes, enzymes, acids, crude drugs, and mouth rinses or oral rinses for dentures.[15]

A literature review revealed few clinical studies, especially those targeting the hospitalized geriatric population. The efficacy of some cleansers has been tested in the laboratory, but the results of laboratory studies do not necessarily agree with experience in vivo.[16]

It was the purpose of this study to determine the effectiveness of the cleansers Denture Brite, Polident Overnight and Efferdent New Concentrated Blue Tablet in reducing *Candida* spp. and bacteria on denture surfaces as well as in dislodging food and reducing plaque and stain in a geriatric population living in a long-term care institution.

Material and Methods

Study Population

This randomized crossover study was approved by the Research and Ethics Committees of the Sir Mortimer B. Davis Jewish General Hospital (SMBD JGH) and the Jewish Nursing Home (JNH), Montreal, Quebec.

Subjects were eligible if they were edentulous and had a complete acrylic upper denture. Subjects with partial dentures or lower dentures only and those who had used a denture cleanser within the previous 2 weeks were not eligible. Subjects were selected by one dental hygienist (I.P.) between January and May 2000 from the residents of the long-term care facilities of the SMBD JGH and the JNH. Thirty-seven patients were invited to participate in this study. Of these, 2 were unable to participate because of their emotional state, 3 refused and 5 of those who accepted were discharged after randomization but before the data were collected. For the remaining 27 patients, 14 men and 13 women, mean age was 84 (standard deviation 8.8) years.

Clinical Examination

After signing the consent form, each subject underwent a complete oral examination; all examinations were performed by a single dentist.

Randomization and Blinding

Subjects were assigned at random to 1 of 4 groups, independent of any other factors (e.g., sex); each study group received 1 of the 3 denture cleansers or water (control).

Two dental hygienists (I.P. and A.M.M.) were responsible for the treatment protocol. The patients, the microbiologist responsible for the cultures and the dentists involved in the evaluation of the dentures were blinded as to treatment group.

Treatment Protocol

Three commercial denture cleansers were used in this study. Denture Brite (Advantage Products, Langley, British Columbia) is an oxygen producer that contains potassium peroxymonosulfate, potassium bisulfate, potassium sulfate and potassium peroxybisulfate; its pH is 1.8. Polident Overnight (GlaxoSmithKline Consumer Health Group, Oakville, Ontario) and Efferdent New Concentrated Blue Tablet (Pfizer Consumer Health Care, Scarborough, Ontario) are carbon dioxide producers that contain citric acid, sodium bicarbonate and potassium monosulfate (pH 7.0 and 7.5, respectively).

For all patients, water only was used to clean dentures for an initial one-week period before the study began. Then, the assigned cleanser or water (control) was used to clean dentures in the first week. In the crossover design, the other cleansers were used for 1-week periods separated by a 1-week wash-out (during which water only was used). The wash-out periods

were intended to allow *Candida* spp. and bacteria to repopulate the dentures and to eliminate the effects of the previous cleanser.[17] The total study period was therefore 35 days: three 7-day periods of cleanser use (21 days) and two 7-day periods of wash-out with water (14 days).

Cleaning with the commercial products was performed according to the manufacturers' instructions. For Denture Brite, an initial overnight cleaning was followed by 20-minute cleaning sessions on each subsequent day. For Polident Overnight and Efferdent New Concentrated Blue Tablet, dentures were soaked overnight on each day of the study periods. For the control group, dentures were placed in a water bath overnight.

The majority of patients in this study were unable to care for themselves. The patients and their attendants were advised not to clean dentures for the duration of the study, and a notice to this effect was placed above each participant's bed.

Data Collection

Laboratory assessment of Candida *spp. and* Streptococcus mutans

One week before initiation of treatment, the dentures of all participants were cleaned in an ultrasonic bath for 5 minutes to standardize the number of *Candida* spp. and bacteria on the surface of the appliance. Swabs for culture were taken by one investigator (G.L.) from the palatal surface of the upper denture according to a 2 cm x 2 cm template defining the area to be swabbed. Each swab was placed in a culture tube (Culturette, Becton Dickinson, Sparks, Maryland), which was stored in a refrigerator and sent to the University of Montreal bacteriology department within 6 hours.

Samples for culture of *Candida* and *Streptococcus mutans* were taken in the same way by the same investigator on the first day of each week of treatment, before use of the cleanser (days 1, 15 and 29 of the study), and on the first day after discontinuation of treatment (days 8, 22 and 36).

Accumulation of Plaque, Stain and Food

To determine the efficacy of the cleansers relative to that of water (control) in reducing accumulation of plaque, stain and food, 2 photographs of each participant's dentures were evaluated by 3 dentists. These photographs were taken before (day 1) and after the first treatment period (day 8 — first week of study) by a member of the audiovisual department of SMBD JGH.

Study Outcomes

In the intention-to-treat analysis, the primary outcome was the number of colony-forming units (CFU) of oral *Candida* spp. and *Streptococcus mutans* isolated after treatment. In this analysis all patients allocated to each arm of the treatment regimen were analyzed together as representing that treatment arm, whether or not they received or completed the prescribed regimen.[18]

The secondary outcomes were mean visual analogue scores of plaque, stain and food accumulation on the dentures before and after treatment, as determined from photographs of the patients. Three such scales were established: no plaque (0 mm) to heavy accumulation of plaque (100 mm); no stain (0 mm) to heavy accumulation of stain (100 mm); and no food (0 mm) to heavy accumulation of food (100 mm). The dentists examining the photographs marked their assessments with a line on the scale according to the scale definitions. The greater the score of the difference in degree of accumulation of plaque, stain and food between photographs obtained before and after treatment, the lower the efficacy of the treatment.

Intra-class correlation (ICC) was assessed to estimate the extent of agreement between dentists scoring the photographs in relation to the level of accumulation of plaque, stain and food observed. Agreement was very good for level of plaque (ICC = 79%), stain (ICC = 79%) and food (ICC = 81%).

Statistical Analysis

The difference in the number of CFUs of microorganisms between day 1 (first baseline) and day 8 for each treatment protocol was examined to assess the effect of the cleansers relative to that of water. As this variable was not normally distributed, the natural logarithm, exponential square root and rank of these differences were also determined. Four criteria for normality were examined: the median, the coefficient of skewness, the coefficient of kurtosis and the p value of the Kolmogorov goodness of fit for normality. The rank of the difference was better in producing nearly normal distributions, so was used in the statistical parametric test (analysis of variance or ANOVA). The rank represents the position of each observation after sorting the variables by value.

A general linear model was used to appraise differences in efficacy between cleansers. For these analyses, the mean of the difference in the number of CFUs before (days 1, 15 and 29) and after (days 8, 22 and 36) each study period was estimated. The distributions of these differences were not normal, so ranks were determined. In the statistical analysis the mean of the differences in ranks for each period (days 1–8, days 15–22 and days 29–36) was used to test differences in efficacy between cleansers. In this multivariate analysis encompassing all study periods, the significance was analyzed with adjustment by difference of treatment, the treatment sequence, the variance between study periods and the variance between subjects.

The mean of the differences in the visual analogue score for accumulation of plaque, stain and food before (day 1 or first baseline) and after use of cleanser (day 8) were used to estimate the efficacy of the cleansers. All of these analyses

were performed with SAS software (SAS Institute Inc., Cary, North Carolina).

Results

Fourteen (52%) of the 27 patients presented with denture stomatitis (Table 1). According to the Newton classification of denture stomatitis,[19] 5 of the patients had grade 1, 2 had grade 2a, 3 had grade 2b, 2 had grade 3a and 2 had grade 3b. There was no difference between groups with regard to the presence of stomatitis ($\chi^2 = 1.94$, 3 degrees of freedom [df]; $p = 0.59$), age ($\chi^2 = 1.10$, 4 df; $p = 0.37$) or sex ($\chi^2 = 3.09$, 3 df; $p = 0.38$).

Efficacy of Cleansers

The rank of the differences in numbers of CFUs of *Candida* spp. before and after the use of Denture Brite ($p = 0.04$) and Polident ($p = 0.01$) for the first study period were significantly greater than the control group (Table 2); however, there was no significant difference between Efferdent and control ($p = 0.10$). No significant differences in reduction of *Streptococcus mutans* were observed between Denture Brite ($p = 0.13$) or Polident ($p = 0.12$) and the control group, whereas dentures cleaned with Efferdent had significant reduction of *Streptococcus mutans* ($p = 0.02$) (Table 2).

There was substantial variance among the 3 cleanser groups in the number of CFUs of *Candida* spp. and *Streptococcus mutans* at the end of the various study periods. In a multivariate analysis encompassing all study periods, there was a significant difference in the rank of the number of CFUs of *Candida* spp. ($F = 2.53$; $p = 0.005$). Dentures treated with Denture Brite appeared to have significantly greater reduction in the number of *Candida* spp. than those treated with Efferdent ($p = 0.06$). No differences were observed between Denture Brite and Polident ($p = 0.25$) or between Polident and Efferdent ($p = 0.43$) (Table 3).

In addition, the difference in the rank of the number of CFUs of *Candida* spp. was associated with the variance between study periods ($F = 4.76$; $p = 0.01$) and with the variance between subjects ($F = 2.25$; $p = 0.008$), and not to the treatment sequence ($F = 1.34$; $p = 0.27$).

There was no significant difference in number of CFUs of *Streptococcus mutans* between cleansers (Table 4). Additionally, no significant difference was noted among individuals ($F = 1.34$; $p = 0.22$), treatment groups ($F = 0.38$; $p = 0.69$), study periods ($F = 0.31$; $p = 0.74$) or treatment sequence ($F = 0.37$, $p = 0.69$).

Efficacy in Dislodging Food and in Reducing Plaque and Stain

The mean differences in the visual analogue score for accumulation of plaque, stain and food over one treatment period (day 1 to 7) for dentures treated with Denture Brite, Polident or Efferdent were significantly different from those for dentures in the control group. There were no differences between cleansers in this respect (Table 5).

Discussion

During the first study period (days 1 to 7), the cleansers had different levels of effectiveness in reducing the 2 main types of microorganisms. Denture Brite and Polident were more effective than water in reducing *Candida* spp. In

Table 1 **Baseline characteristics of 27 elderly patients in long-term care institutions**

Characteristic	Treatment group			
	Denture Brite ($n = 7$)	Polident ($n = 7$)	Efferdent ($n = 7$)	Control (water) ($n = 6$)
Mean age (years)[a]	79.2	83.6	84.0	80.0
No. of males[a]	4	4	4	2
No. with stomatitis[a]	4	4	4	2

[a]*No significant difference between any cleanser and control ($p > 0.05$)*

Table 2 **Mean difference[a] and rank of mean difference in number of colony-forming units (CFUs) of *Candida* spp. and *Streptococcus mutans* over the first study period (days 1–7)**

	Candida spp.		*Streptococcus mutans*	
Treatment group	Mean difference (SD)	Rank of mean difference (SD)	Mean difference (SD)	Rank of mean difference (SD)
Denture Brite	285,017.8 (301,608.3)	51.3[b] (17.2)	244,083.3 (691,133.9)	41.7 (30.0)
Polident	560,040.3 (624,715.1)	58.4[b] (17.9)	21,528.6 (37,257.7)	42.0 (11.9)
Efferdent	237,408.9 (948,334.4)	43.6 (31.4)	348,545.0 (517,007.3)	51.4[b] (30.3)
Control (water)	–35,991.7 (140,008.9)	*22.5* (21.4)	–557,382.5 (1,223,408.4)	19.6 (19.4)

SD = standard deviation

[a]*Number of CFUs at baseline minus number of CFUs on day 8; positive values represent a reduction and negative values an increase in the number of CFUs relative to baseline*

[b]*Significant difference between cleanser and control (*$p < 0.05$*)*

Table 3 **Mean difference[a] and rank of the mean difference in number of colony-forming units (CFUs) of *Candida* spp.**

	Study period 1 (days 1–7)		Study period 2 (days 15–21)		Study period 3 (days 29–35)	
Treatment group	Mean difference (SD)	Rank of mean difference (SD)	Mean difference (SD)	Rank of mean difference (SD)	Mean difference (SD)	Rank of mean difference (SD)
Denture Brite	285,017.8 (301,608.3)	51.3 (17.2)	91,775.2 (130,014.6)	36.8 (19.6)	2,581.6 (51,239.1)	29.3 (12.9)
Polident	560,040.3 (624,715.1)	58.4 (17.90)	155,547.1 (231,866.2)	43.1 (17.9)	489,047.1 (1,162,486.6)	42.7 (21.0)
Efferdent	237,408.9 (948,334.4)	43.6 (31.4)	566,514.5 (562,780.2)	52.1 (28.0)	32,915.5 (56,366.6)	32.6 (14.0)

SD = standard deviation

[a]*Number of CFUs at baseline minus number of CFUs on day 8; greater values represent a greater reduction in the number of CFUs relative to baseline*

Table 4 **Mean difference[a] and rank of the mean difference in number of colony-forming units (CFUs) of *Streptococcus mutans***

	Study period 1 (days 1–7)		Study period 2 (days 15–21)		Study period 3 (days 29–35)	
Treatment group[b]	Mean difference (SD)	Rank of mean difference (SD)	Mean difference (SD)	Rank of mean difference (SD)	Mean difference (SD)	Rank of mean difference (SD)
Denture Brite	244,083.3 (691,133.9)	41.7 (30.0)	42,583.3 (71,024.2)	42.2 (20.3)	–57,636.0 (259,344.5)	34.8 (27.8)
Polident	21,528.6 (37,257.7)	42.0 (11.9)	279,660.0 (666,992.8)	47.1 (19.9)	77,531.4 (123,293.3)	46.4 (19.9)
Efferdent	348,545.0 (517,007.3)	51.4 (30.3)	16,644.9 (30,956.3)	32.2 (19.2)	204,133.3 (410,329.3)	49.3 (21.1)

SD = standard deviation

[a]*Number of CFUs at baseline minus number of CFUs on day 8; positive values represent a reduction and negative numbers an increase in the number of CFUs relative to baseline*

[b]*There were no significant differences among cleansers (*$p > 0.05$*)*

contrast, the reduction in the number of *Streptococcus mutans* was significantly greater with Efferdent than with water (Table 2). The use of cleanser significantly reduced the amount of plaque, stain and food on the dentures (Table 5).

The significant difference between cleansers in rank of reduction in *Candida* spp. was not related to the treatment used but to the variability in the number of CFUs of *Candida* spp. between the 3 study periods and between subjects (Table 3). The effects of a cleanser in vivo are constantly challenged by the daily ingestion of food, which may explain at least part of the variability between study period and subjects.

The large variability in the number of microorganisms may explain the discrepancies in results between various studies. In another study, involving 15 patients wearing complete maxillary and mandibular dentures, Efferdent was a little more effective than Polident in reducing plaque but less effective than other cleansers (Mersene and Clorox-Calgon).[20] McCabe and others[17] did not find significant differences between cleansers in the reduction of calculus.

The validity of the results of this study relate to methodology. Two trained hygienists, following the same protocol to decrease bias among groups, applied the treatments. Individual patients were not informed about the study hypotheses, and the microbiologist who cultured swab samples was blinded to treatment. Another advantage was the long wash-out period (7 days) between treatment periods to allow accumulation of *Candida* spp. and bacteria. Furthermore, the most accurate method of examining microbial plaque was applied in this study.[16] Finally, the very good agreement among the 3 dentists in terms of scores related to plaque, stain and food, in spite of obvious interoperator subjectivity, contributed to the validity of our results.

Table 5 **Mean difference[a] and rank of mean difference in accumulation of plaque, stain and food over the first study period (days 1–7)**

Treatment group	Mean difference (and rank of mean difference)[b]		
	Plaque	Stain	Food
Denture Brite	16.9 (33.8)	16.2 (27.0)	20.1 (34.1)
Polident	14.1 (29.7)	25.6 (36.5)	18.1 (31.3)
Efferdent	13.9 (31.3)	21.6 (34.2)	19.0 (30.3)
Control (water)	62.3 (66.3)	61.0 (61.7)	65.8 (65.2)

[a]*Rating at baseline minus rating on day 8 (mean of assessments by 3 dentists); lower values represent a reduction in ranking relative to baseline*

[b]*For each variable (plaque, stain and food), there was a significant difference between each cleanser and the control group (*$p > 0.0001$*) but no significant differences between the cleansers*

However, this study had some limitations. The subjects were selected in 2 locations, which might limit the generalizability of the results. In addition, even though most of the patients had physical limitations that would have prevented them from cleaning their own dentures, it was not possible to verify whether they did so. Another constraint was that the presence of microbes was evaluated at only one specific position on the denture. It has recently been suggested that it is preferable to identify microorganisms in denture plaque from the whole surface of the denture.[16] The unspecified types of *Candida* spp. also represent a limitation. The difficulty in distinguishing between plaque, stain and food debris on the photographs should also be considered a potential limitation.[21] Finally, the small sample size in this study limited the power of the analyses and constrained the interpretation of our results.

The significant reduction in the number of microorganisms, plaque, stain and food observed in this study suggests that the use of denture cleansers is a suitable method for cleaning dentures in the geriatric hospitalized population. This conclusion is supported by the finding of Chan and others[14] that brushing alone with a denture abrasive was less effective than cleanser use for maintaining good denture hygiene. Those authors suggested that cleanser use may be particularly appropriate for elderly people who lack manual dexterity.[14] Of concern was the increase in the number of microorganisms observed when dentures were soaked in water. Further studies are needed to determine if daily use of a cleanser can reduce the high prevalence of denture stomatitis in such patients (52% in this study group) or if it might cause mucosal irritation and allergy.[22] ◆

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CDA Resource Centre

CDA members can borrow the following videos on dental care for institutionalized geriatric patients:

Indiana State Department of Health, A caregiver's guide to oral health, *[31 minutes], 1992.*

West Virginia University Health Sciences, *Oral care for the dependent patient*, [20 minutes], 1990.

Dental Health Video Source, *The skills of daily mouth care*, [23 minutes], 1995.

For more information, contact the Resource Centre at tel.: **1-800-267-6354** or **(613) 523-1770**, ext. 2223; fax: **(613) 523-6574**; e-mail: **info@cda-adc.ca**. Shipping charges and taxes apply.

BOARD OF GOVERNORS

NOTICE OF MEETING
Interim Meeting

The Interim Meeting of the Board of Governors of the Canadian Dental Association will be held March 15 and 16, 2002 (Friday and Saturday), at the Westin Hotel, Ottawa, commencing at 10:30 a.m.

Simultaneous interpretation will be made available provided that a member requests and confirms that he/she will utilize this service. Notice must be provided to Lucy Dumoulin, Coordinator, Board, at least 10 days in advance of the meeting date.

The Board is composed of 26 governors with voting privileges and a chair. Governors represent members across Canada on a 1 to 500 ratio. The Canadian Forces Dental Services and student members are represented by one member each.

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