



EFFICACY OF ANTI-PLAQUE AGENT IN BIOFILM REDUCTION ON REMOVABLE COMPLETE DENTURES: A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Background: Complete removable dentures are susceptible to biofilm accumulation, which may lead to oral complications such as denture stomatitis, poor oral hygiene, unpleasant odor, and discomfort among edentulous individuals. Maintaining proper denture hygiene is essential to minimize these complications. Chemical denture cleansers, including 0.12% chlorhexidine mouthwash and Clinsodent denture cleansing tablets, are commonly used to control plaque and maintain denture cleanliness. **Aim:** To evaluate and compare the plaque-reducing effectiveness of 0.12% chlorhexidine mouthwash and Clinsodent denture cleansing tablets in complete denture wearers. **Materials and Methods:** A randomized controlled trial was conducted among 20 participants with new removable complete dentures. Participants were randomly divided into two groups (N=10 each). Group 1 disinfected dentures by overnight soaking in a 0.12% chlorhexidine mouthwash solution, while Group 2 soaked dentures overnight in a Clinsodent solution containing 480 mg sodium perborate monohydrate. All participants cleaned dentures daily with a soft-bristle toothbrush and water for 20 days. Biofilm evaluation was performed using AlphaPlac plaque-disclosing solution, and denture photographs were visually assessed to estimate plaque-covered surface area. Statistical analysis was conducted using IBM SPSS Statistics version 27.0 with an unpaired t-test. **Results:** Both cleaning methods reduced biofilm accumulation. Mean biofilm scores were 1.13 ± 1.00 for Clinsodent and 0.95 ± 0.67 for chlorhexidine, showing a statistically significant difference ($P < 0.05$). **Conclusion:** Chlorhexidine mouthwash was slightly more effective than Clinsodent, though both products effectively reduced denture biofilm levels.

KEYWORDS: Complete Dentures, Denture Biofilm, CHX, Denture Cleanser, Denture Care, Randomised Controlled Trial.

INTRODUCTION

Most elderly people have little to no teeth (edentulous), which is a significant issue. With loss of teeth, the elderly have difficulty in chewing food, talking, aesthetics and living a fulfilling life. Complete dentures have been prescribed for restoring the mouth to function normally and/or how an individual is perceived with the absence of their teeth. The effectiveness of complete dentures can be severely compromised due to lack of hygiene in maintaining the dentures (for example, not brushing the dentures on a daily basis). If a person is not practicing good hygiene in relation to their dentures, it is possible to accumulate bacterial/yeast growths on the denture surface that could lead to both intraoral (oral

cavity) and systemic diseases. The use of chlorhexidine is often suggested to patients as it is an effective disinfectant based on its broad-spectrum effectiveness against all of the different types of oral flora, including bacteria and yeast. Many applications of chlorhexidine in prosthodontics support the claims that chlorhexidine inhibits the growth of bacteria and helps to remove plaque in the mouth and on prostheses.^[1] Many research studies have also examined the effectiveness of mouth rinses and denture cleaning solutions in reducing the microbial colonization of denture materials, including fungal organisms such as *Candida albicans*.^[2] Past studies have shown that chlorhexidine solutions can significantly reduce the accumulation of denture biofilm

as well as increase the cleanliness of dentures as long as they are used as part of a routine denture hygiene regimen.^[3] The need for proper denture hygiene is critical to prevent oral diseases caused by the use of dentures. People do face some difficulties in maintaining proper hygiene of dentures due to insufficient knowledge regarding proper cleaning techniques and the uneven surface of their dentures which creates an environment conducive to plaque accumulation.^[4] Chlorhexidine has been researched extensively for its pharmacological uses, clinical uses and potential side effects in the dental field.^[5] In addition to the use of antimicrobial mouth washes, many chemical denture cleaning products have been created to promote good denture hygiene and decrease bacterial adhesion to denture base materials.^[6] The majority of current recommendations for chemical denture cleansing agents are to supplement routine mechanical cleaning methods such as brushing. These products help in the removal of plaque build-up, decrease the presence of bacteria and thus improve the overall cleanliness of removable prostheses. As documented in the literature, various studies evaluating modern denture cleaning methods have proven they can greatly decrease biofilm build-up on complete denture wearers.^[7] Insufficient denture hygiene and prolonged periods of bacterial colonization have been linked with denture stomatitis which is an inflammatory condition that frequently occurs in denture wearers and is often associated with an infection from species of *Candida*.^[8]

Denture biofilm consists of various microorganisms such as bacteria, fungi and various other microbes which adhere to the surface of the denture and forms structured plaque deposits.^[9] One of these microorganisms, specifically *Candida albicans*, is responsible for causing infections related to dentures and readily colonizes acrylic denture base materials under the right conditions.^[10] Dentures that are covered in these types of biofilms may not only contribute to localised oral inflammatory processes but might also act as reservoirs for pathogens, potentially causing systemic infections in those who are elderly and/or have other health issues. Finding the best way to control denture biofilm accumulation is still a significant clinical issue, even when so many types of denture cleaning supplies exist. Comparative evaluation of different denture cleansing agents may help identify effective and convenient strategies for improving denture hygiene and preventing plaque accumulation. This study compared 0.12% chlorhexidine mouthwash and Clinsodent denture cleaning tablets for their effectiveness as anti-plaque agents on removable complete denture biofilm. The purpose of this study was to determine how much biofilm could build up on a complete denture and to compare chlorhexidine mouthwash with Clinsodent cleaning tablets as an effective method of killing plaque. The null hypothesis was that there would be no difference in how well the two methods could remove denture biofilm. The alternative hypothesis was there

will be significant difference between the denture cleansing tablet and CHX mouthwash.

MATERIALS AND METHODS

Study Design and Setting

A randomized controlled clinical trial was conducted to evaluate the efficacy of the two types of denture cleaning agents to analyze how effectively they inhibit plaque that forms on removable complete denture(s) from the day new complete dentures were delivered until they were evaluated at the end of 20 days. All subjects in the study were patients receiving new complete dentures as part of their treatment at the Prosthodontics department of a dental school. Ethical issues were addressed before conducting this study. All subjects were informed of the nature and purpose of the study prior to their participation in the study and written consent was obtained.

Study Population

Twenty participants who were completely edentulous and required new complete dentures were included in the study. All the participants received new complete dentures. To ensure unbiased selection and evenly distribute participants into the two groups the patients were randomly divided into two groups having 10 patients each by using coin toss method.

Inclusion and Exclusion Criteria

Individuals participating in the trial must meet specific entry-level requirements that have been previously established through an inclusion/exclusion process. The study will include any individual being given their first new removable complete denture within their maxilla, mandible or both maxilla and mandible. In addition, individuals must agree to adhere to the denture hygiene protocol given at the beginning of the trial and provide informed consent to participate in the study. Patients with partial dentures or who had been wearing removable dentures before the study began are excluded. Individuals with systemic diseases or oral lesions have also been excluded because these diseases or lesions can impact the results of the study specifically regarding plaque accumulation and denture hygiene. Patients who refuse to comply with the research protocol were also excluded.

Group Allocation

The 20 participants were randomly assigned to Group 1 (using a solution of 0.12% chlorhexidine mouthwash) and Group 2 (dissolved Clinsodent denture tablets in water). Participants in both groups were instructed to remove their dentures overnight and soak them in the respective solutions daily for the duration of the study.

Intervention Procedure

Before starting the trial, all participants were educated on how to keep the dentures clean and in good condition. People were taught how to properly clean their dentures on a regular basis (every day) using water and a soft

toothbrush to remove visible food particles and/or plaque deposits on the dentures. The subjects in Group 1 were instructed to take out their dentures at night and place them overnight in a container filled with 0.12% chlorhexidine mouthwash. Chlorhexidine is a broad-spectrum anti-bacterial/antifungal agent for use against both bacterial and fungal properties. Chlorhexidine has been found to remain on surfaces long enough to have a considerable effect on reducing or eliminating pathogenic microorganisms (biofilm). The subjects in Group 2 were directed to remove their dentures at night and immerse them in a solution of water and Clinsodent denture cleaning tablets, following the manufacturer's instructions. The Clinsodent tablets contain effervescent ingredients that generate oxygen bubbles to help loosen debris and facilitate the removal of plaque from denture surfaces. Both groups followed the assigned oral care routine for the study duration of 20 days.

Biofilm Assessment

Denture biofilm was evaluated by the investigators at both baseline and completion of the study (20 days). The evaluation of the presence of biofilm was limited to the internal (tissue coming into contact with the surface of the denture) surfaces of both maxillary and mandibular dentures. Therefore, after applying a disclosing solution,

photographs of the denture surface area were captured using a Canon EF-S digital camera and consistent lighting. Each photograph represented an area of plaque on the denture surface based on the amount of plaque around that area, recorded in percentage of total denture surface area.

Plaque Scoring

Biofilm accumulation on the denture surfaces was assessed based upon the amount of biofilm covering the examined denture surfaces at the end of the study. The stained areas were representative of the number of plaque deposits accumulating on the denture surfaces and the amount of staining across the stained areas was used to calculate a plaque score for each subject. The plaque scores determined for each of the subjects at the conclusion of their respective studies were compared to the baseline (original) values of the subjects to determine how effective the denture-cleansing agents were at decreasing the amount of biofilm accumulation. The retention of plaque both on the intaglio surfaces of dentures and in the predefined locations for plaque assessment are shown in Figures 1 and 2. The intaglio surfaces of the maxillary and mandibular dentures were divided into predefined areas as detailed in Tables 1 and 2 for plaque assessment.

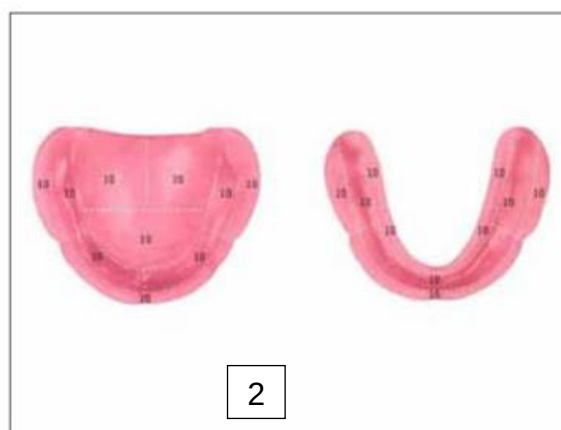
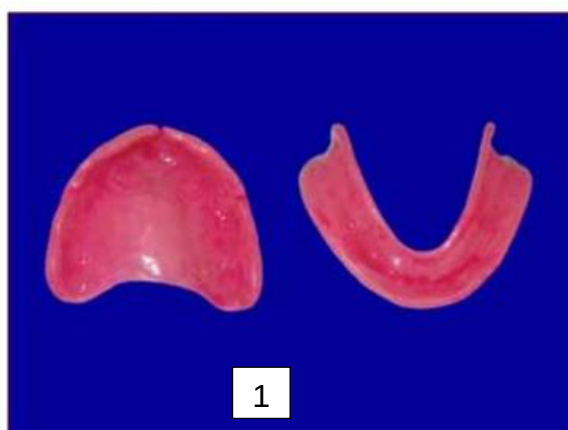


Figure 1: Areas in which plaque is retained on the fit (intaglio) surfaces of maxillary and mandibular complete dentures. **Figure 2:** Areas where DPI (Denture Plaque Index) was evaluated.

Table 1: Areas of plaque retention on the intaglio surfaces of maxillary complete dentures.

Area designation	Plaque retention area description
1	Mesial of central incisor to distal of right 1st premolar
2	Mesial of central incisor to distal of left 1st premolar
3	Distal of 1st premolar to the right posterior end
4	Distal of 1st premolar to the left posterior end
5	Distal of right canine to distal of left canine
6	Distal of right canine to the right posterior end of flange
7	Distal of left canine to the left posterior end of flange
8	Rugae area
9	Posterior palatal area bounded by rugae anteriorly, midpalatal suture medially, rugae anteriorly, and distal flange laterally on right side
10	Posterior palatal area bounded by rugae anteriorly, midpalatal suture medially, rugae anteriorly, and distal flange laterally on left side

Table 2: Areas of plaque retention on the intaglio surfaces of mandibular complete dentures.

Area designation	Plaque retention area description
1	Distal of right canine to distal side of left canine
2	Distal of right canine to the right posterior end of crestal surface
3	Distal of left canine to the left posterior end of crestal surface
4	Distal of right canine to distal of left canine on facial flange
5	Distal of right canine on facial flange
6	Distal of left canine on facial flange
7	Lingual area from midline to half distance to distal end on right side
8	Disto-lingual half of the lingual flange on right side
9	Lingual area from midline to half distance to distal end on left side
10	Disto-lingual half of the lingual flange on left side

Statistical Analysis

The data from all participants were entered and analyzed with Microsoft Excel and IBM SPSS Statistics version 27.0; descriptive statistics - means and standard deviations were calculated on the plaque scores from both groups. An inferential statistical analysis was completed to compare the plaque score of both groups. The intergroup comparison was completed using an unpaired t-test, which is suitable for comparing two independent groups' means. Statistical significance was indicated at a level of < 0.05 via a p-value analysis. The statistics were used to determine whether there was a statistically significant difference between the biofilm accumulation on dentures of people using Chlorhexidine mouthwash and Clinsodent denture cleansing tablet.

RESULTS

A total of 20 participants who received new removable complete dentures completed the study protocol. After the 20-day intervention period, plaque accumulation on the intaglio surfaces of the dentures was assessed using a plaque disclosure method. Representative images depicting plaque accumulation on denture surfaces following plaque disclosure are illustrated in Figure 3.

To assess plaque distribution on the denture surface, each denture's intaglio surface was divided into 10 pre-determined areas. Mean plaque scores were calculated for each area for both study groups and are included in Table 3. For the Clinsodent study group, the distribution of plaque was not evenly distributed among the areas that were assessed: some anterior denture areas had comparatively low plaque accumulation, while many posterior and lateral regions had higher amounts of

plaque accumulation. The results found indicate that there is a variable degree of cleaning effectiveness by the Clinsodent cleaning regimen on the various denture surface areas.

A different plaque distribution pattern was seen in the chlorhexidine study group than in the Clinsodent group. For the chlorhexidine study group, anterior denture regions had relatively higher levels of plaque; however, a number of posterior and peripheral denture regions had less plaque accumulation. This finding indicates that the chlorhexidine mouthwash cleaning method was able to achieve reduced plaque accumulation on multiple areas on the denture surface. Figure 4 provides a graphical comparison of the plaque scores obtained from the two denture cleaning methods for the 10 denture surface areas. The graph shows that Clinsodent and chlorhexidine exhibited different patterns of plaque accumulation across the denture surfaces in the assessed areas. The overall comparison of plaque scores between the two study groups is summarized in Table 4. Statistical analysis using the unpaired t-test demonstrated a statistically significant difference between the two cleansing regimens ($p < 0.05$). The chlorhexidine group demonstrated comparatively lower plaque scores than the Clinsodent group, indicating better plaque control with the chlorhexidine regimen during the study period. Both cleansing protocols were effective in reducing denture biofilm accumulation over the study duration. However, the overall pattern of plaque distribution across the denture surfaces suggests that the chlorhexidine regimen provided comparatively improved plaque control in several evaluated regions of the dentures.

Table 3: Area-wise comparison of mean plaque scores.

Area	Clinsodent	Chlorhexidine
1	0.9	1.0
2	0.9	1.3
3	0.9	0.9
4	0.7	1.0
5	1.4	1.1
6	1.7	1.0
7	1.2	1.1
8	0.9	0.4
9	1.3	0.8
10	1.4	0.9

Table 4: Overall comparison of plaque scores.

Group	Mean	SD	P value
Clinsodent	1.13	1.00	0.00*
Chlorhexidine	0.95	0.67	

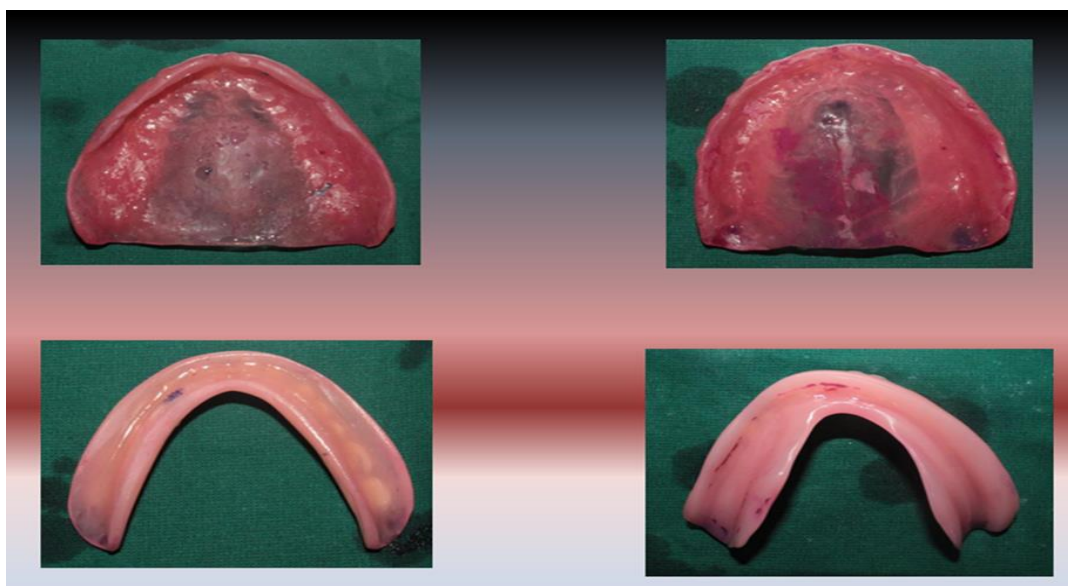


Figure 3: Representative photograph of maxillary and mandibular complete dentures showing plaque disclosure on the intaglio surfaces used for evaluation of denture biofilm.

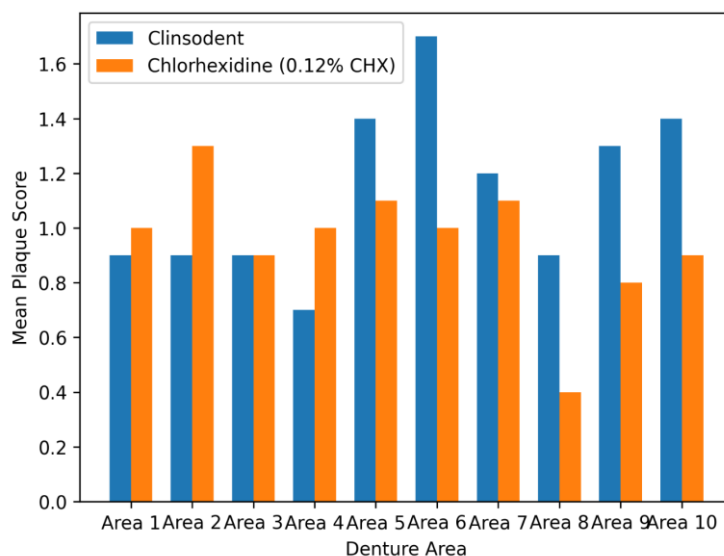


Figure 4: Graphical comparison of mean plaque scores between Clinsodent and 0.12% chlorhexidine groups across the ten evaluated denture areas.

DISCUSSION

The study aims to assess the efficacy of two commonly used methods of cleaning dentures, chlorhexidine mouthwash (0.12% solution) and Clinsodent denture cleaning tablets, in terms of removing the plaque that forms on removable complete dentures. Denture cleaning is one of the most important aspects of maintaining good oral health care for people without teeth. If not done properly, microorganisms will build upon the surface of the denture, resulting in various infections of the oral cavity, including denture stomatitis, inflammation of the

mucosal tissues around the denture, and other complications.^[11] Therefore, appropriate cleansing methods must be used to control the build-up of plaque and to have continued good oral health for denture users.^[12] The findings from the study indicate that both cleaning agents reduced the amount of biofilm on the denture. However, Chlorhexidine demonstrated a lower mean level of the amount of plaque compared to the Clinsodent group, suggesting that the use of Chlorhexidine mouthwash is superior to the use of Clinsodent for controlling plaque. Chlorhexidine had an

overall mean plaque count of 0.95, while that of the Clinsodent was greater at 1.13. The difference between both groups was statistically significant when analysed. The results suggest that Chlorhexidine mouthwash has higher ability to reduce plaque from dentures when compared to Clinsodent.

The superior antiseptic activity of chlorhexidine may be an effect of its antimicrobial activity toward many types of microorganisms. Chlorhexidine is one of the most widely accepted and clinically proven topical antiseptics used in the field of dentistry. It is bactericidal and fungicidal against many types of microorganisms such as Gram-positive and Gram-negative bacteria, and certain types of fungi (*Candida albicans*), which have been shown to cause denture-related infections.^[13] Moreover, chlorhexidine possesses substantivity, or the ability to bind to oral surfaces and remain active for an extended period, thereby providing a prolonged antimicrobial effect.^[14] In contrast, standard denture cleaning tablets such as Clinsodent primarily utilize effervescence to create chemical reactions that release a mass of oxygen bubbles when the tablets dissolve in water. These oxygen bubbles are effective at dislodging debris and plaque from the surface of dentures.^[15] Although effervescent products may aid in the removal of surface deposits, their antimicrobial effects are less likely to be as potent or enduring as those of chlorhexidine. This disparity in mechanisms of action may account for the greater plaque scores reported for the Clinsodent group in the study.^[16]

The results of the present study align closely with those shown in earlier studies. Research shows clearly that using denture cleaners and disinfectants will necessarily work towards lowering the levels of microorganisms on the surfaces of dentures.^[17] Some studies have shown that regular use of chemical cleansers may reduce some microbial biofilms on dentures, therefore enhancing denture hygiene.^[18] Therefore, the vast majority of these studies provide evidence that chemical-based denture cleaners are quite effective at controlling the formation of denture biofilm.^[19] In addition, many studies looking at various methods for cleaning dentures have demonstrated chemical disinfectants to reduce the incidences of fungal colonization and plaque build-up on dentures.^[20] A number of studies have previously assessed different chemical agents and shown they were effective at reducing the growth of microorganisms and plaque accumulation on acrylic dentures.^[21]

In addition, previous studies indicating proper denture cleaning methods have shown that using mechanical devices (e.g. a toothbrush) along with an antimicrobial chemical will give the most effective results for maintaining and cleaning dentures.^[22] The use of a toothbrush to clean dentures will help to remove food debris and any loose plaque from the denture surface, while a chemical dental product will provide an antimicrobial effect on the denture surface to kill bacteria and enable easy removal of plaque that adheres to the

dentures. Thus, including a chemical cleaner for cleaning the dentures should be part of overall denture care regime.^[23] While this study found positive results, there were some limitations to be aware of when discussing results. Small sample size of only 20 participants makes it necessary to conduct future research using larger sample sizes to allow for more accurate estimation of how many people experience the same level of success with respect to cleaning their dentures. Additionally, since this study was conducted over only 20 days, it is possible that these findings do not accurately reflect how well each cleaning method performs over time. Therefore, longer follow-up studies are needed to assess the efficacy of denture cleaning products over extended periods of time.^[24]

This study focuses on measuring how much plaque has formed on the surface of the denture; therefore, there is no way to identify or evaluate the number of microorganisms on the denture or what types of bacterial pathogens contribute to the formation of plaque biofilms on the surface of the denture. More research needs to be done in order to obtain accurate clinical microbiological identification of the type of microorganisms in order to evaluate the efficacy of each of the cleaning agents regarding specific microorganisms. Results from this study conclude that chemical cleaning agents are useful for keeping the dentures clean for the participants in this study. The tested chemical cleaning agent found to have the greatest ability to remove biofilms from the denture was 0.12% chlorhexidine mouthwash as compared to Clinsodent cleaning tablets, which had less effect on removing biofilm from the dentures. The study's results suggest that routine cleaning of dentures with chlorhexidine should be used as a part of the daily denture cleaning regimen.

Strengths and Limitations of the Study

There are several important strengths of this study. A randomized controlled trial design was used to limit selection bias and allow for unbiased subject allocation into the two study groups. The comparison of two well-known denture cleaning agents (i.e., 0.12% chlorhexidine mouth rinse and Clinsodent denture cleaning tablet) contributes to the clinical relevancy of the study because both cleaning agents are widely suggested to clean dentures. Plaque accumulation on complete denture surfaces was evaluated using a plaque disclosing solution, which enables for clear visualization of denture biofilm. Photographic documentation of the evaluation of denture plaque provides a more objective measure of evaluation. The study was conducted on patients with removable complete dentures, which closely mirrors what occurs in everyday practice and increases the practical application of the study findings.

This study provides useful insight into the efficacy of denture cleansing agents. However, there are some limitations of this study that need to be addressed before drawing any definitive conclusions from it. The

limitations include that the sample size (20 participants) may limit the generalizability of the data. The timeframe of data collection (20 days) may not accurately reflect the long-term efficacy of denture cleansing agents. Furthermore, this study primarily focused on quantifying the amount of plaque on denture bases using photographic images rather than conducting microbiological testing to identify the types of microorganisms present on the denture biofilm. Both of these limitations influence the results. However, researchers could not accurately assess compliance with the recommendations for denture hygiene, potentially resulting in poorly influenced findings in the study. This study was also conducted at one clinical setting, which would limit the applicability of the findings outside of the setting in which the study was conducted.

Clinical Significance

Results of the study indicate that cleaning dentures (i.e. removable full dentures and partials) regularly can reduce plaque/biofilm formation on dentures by preventing plaque from sticking to or adhering to the denture surface, resulting in healthier mouths and dentures. The presence of denture-stomatitis (thrush) is often caused by poor denture hygiene (i.e. poor cleaning/oral care) as well as other contributing factors including age/advance-age and insulin-dependent diseases such as diabetes. Therefore, improving the quality of the denture(s) through the use of chemical products can help prevent the accumulation of plaque on the denture's surface and thus reduce the chance of developing denture-stomatitis. A significant role in the improvement of oral health and hygiene in the elderly population may be achieved by using chemical (i.e. chlorhexidine or Clinsodent) products to improve the hygiene of the dentures. Chlorhexidine may be more effective than Clinsodent in reducing biofilm build-up on dentures. It is further suggested that chlorhexidine mouthwash is an appropriate adjunct to mechanical (manual) oral-hygiene methods when caring for complete or partial dentures in the elderly when mechanical (manual) denture cleaning is inadequate to maintain appropriate oral hygiene.

FUTURE PERSPECTIVES

More studies are needed to determine how these findings can be further expanded upon. In future research, researchers should look at including larger sample sizes and longer follow-up periods in order to assess how effective each of these types of denture cleaners are in the long run. Microbiological analysis could be conducted on the denture biofilm in order to identify the types of microorganisms that are present and provide better quantitative data regarding the antimicrobial activity. Also, comparing the effectiveness of different methods (i.e., using sodium hypochlorite, enzymatic cleansers, and/or ultrasonic cleaners to clean the dentures) can give us greater insights into effective denture hygiene techniques and practices. By conducting this study, improved denture cleaning protocols can be

created that have the potential to positively impact oral health and improve the quality of life for those people who wear dentures.

CONCLUSION

The study's two primary findings indicate that both Clinsodent denture cleansing tablets and 0.12% chlorhexidine mouthwash are effective at controlling the accumulation of biofilm on removable complete dentures. However, chlorhexidine mouthwash was more effective than Clinsodent tablets in decreasing accumulation of dental plaque on removable complete denture appliances. In addition, the substantially greater substantivity and antimicrobial activity of chlorhexidine as compared to Clinsodent may account for the fact that chlorhexidine produced significantly more plaque control than Clinsodent. The present study's null hypothesis was rejected, indicating that significant statistical difference exists between the two cleansing agents utilized in this study. In light of these findings, chlorhexidine 0.12% is likely the superior chemical agent to provide adequate denture cleaning and reduce biofilm accumulation for complete removable denture wearers.

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