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A Comparative Evaluation of The Efficacy of Commercially Available Chemical Denture Cleansing Materials in The Removal of Tea, Coffee and Turmeric Stains – An in Vitro Study

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Abstract

Introduction: Denture cleanliness is very important to prevent foul breath, non -acceptable aesthetics and the deposition of calculus followed by plaque with its very harmful effects on mucosa. Tea, turmeric, betel, tobacco stains in combination with bacterial plaque accumulates on dentures on an average Geriatric patient inspite of all attempts to produce self-cleansing design for dentures.

Materials and Method: The present in vitro study, to compare and evaluate the efficacy of commercially available chemical denture cleansing materials in the removal of tea, coffee and turmeric stains was conducted in the department of prosthodontics. Measurement of reflectance curve by using Elico SP 150 UV/Visible spectrophotometer.

Results: When compared reflectance of the three groups, one-way ANOVA and Tukey test for testing the differences of mean in between the groups. The significance level was set at P-value ≤0.05.

Conclusion: Clinsodent has a comparatively greater stain removal capability than Safe plus followed by Sodium hypochlorite and Control group i.e., distilled water respectively.

Keywords: Polymethyl methacrylate, denture cleanser, spectrophotometer

Introduction

With ever rising the incidence of edentulousness, now entire focus is on the need for complete dentures and their hygiene. With advanced medical treatment options available, the overall life span of an individual has increased leading to more aged people, so care extended to elderly population has to be meticulously planned followed by its implementation. One of the commonest issues exists among geriatric population is partial or complete edentulousness. Complete dentures are the most common modality of treatment offered to edentulous patient still today. Patients usually take a few months to get habitual to the new prosthesis in the oral cavity called the "adaptation period" after which patients feel quite comfortable with dentures. In order for the complete dentures to effectively compensate for the absence of natural teeth, patient must take care of the dentures.

At the time of insertion of complete denture, besides helping a patient with how to chew with dentures, the prosthodontist must also guide the patient good denture maintenance regime as overnight immersion (in water with denture cleansers), cleaning of dentures in the morning (using denture brush and paste), cleaning the dentures after every meal.

Cleanliness of prosthesis is of utmost importance to prevent foul breath, poor esthetics and the bacterial deposits of plaque and calculus with its harmful effect on soft tissues.

Dentures are polished only on the denture base surfaces, the intaglio part is kept untouched. Acrylic resin bases of both removable and complete dentures attract stains and odour producing organic and inorganic debris. Poorly maintained dentures often leads to a strong repulsive odour widely known as "denture breath[1]."

Tea, turmeric, betel, tobacco stains along with plaque deposits on the dentures on an average Indian patient despite of all efforts to produce self cleansing design for dentures. Continuous neglection in care at home and lack of suitable cleansing, results in deposition of these undesirable products on the dentures surface which may also be responsible for producing adverse tissue response in denture patients[2].

Cleansing of dentures is vital in prevention of cross contamination which further improves the oral health of patient, longevity of the dentures and quality of life. The simplest and most important practice is to remove the dentures from mouth before going to bed. The dentures should be soaked or kept moist to minimize the dimensional changes that occur in acrylic resin as a result of desiccation[3].

A daily routine regimen of denture cleaning should be made for prevention and removal of mucin, food debris, calculus and exogeneous discoloration[4]. Few products have been formulated specifically for removal of denture bio films and classified as chemical and mechanical products[5]. During cleansing by chemical products, a prosthesis needs to be placed in liquids with solvent, antifungal and antibacterial detergent with or without use of brushing or ultrasonic devices[6]. A plethora of denture cleansers are available nowadays,

with claims for their various efficacies. Commercially available denture cleansing systems can be broadly classified into five groups based on their chemical composition and mechanism of action:

1. Oxygenating cleanser (alkaline peroxide)
2. Alkaline hypochlorite solution
3. Dilute mineral acids
4. Abrasive powder and pastes
5. Enzyme containing material (proteases and mutases)

Recent developments also include ultrasonic denture cleansing for removal of plaque by agitation. Some cleansers have been proved to be more superior in stain removal then others.

The efficiency of denture cleansers is very well established, but at same time, it should be always keep in mind that their frequent usage for long time should not lead to any unwanted effect on the acrylic resin denture base and thus no effect on their mechanical and physical properties.

Denture cleansers those are widely available over the counter contain variety of constituents. The soak type cleansers contain oxidizing agents or mineral acids. More recently, enzyme based cleansers are also available now. Other constituents of denture cleansers are coloring, flavoring and surface-active agents. [7,8].

Patients are advised to perform both mechanical and chemical methods for plaque and debris removal from their dentures. Water and a tooth brush is being most widely used manual method for denture cleansing. However, tooth brushes alone proved to be less effective against microbial biofilms on denture but can remove large debris only[9].

Huey-Er Lee et al, stated that 60-90% denture patients used mechanical cleaning along with toothpaste, soap or water[10]. Using toothbrush with toothpaste to remove large particles is most inappropriate cleaning method, which has negative effect on the denture material texture eventually leads to plaque accumulation[11-12]. Whereas soaking of dentures in disinfectant solutions with chemical agents for cleansing leads to deleterious effects on acrylic resin and metal alloy denture base. Current developments suggested that microwaving, UV light and ozonated water might be effective in combating infection. Arita et al stated that ozonated layer can be effective in controlling candida albicans count on dentures. It was suggested to use energy for dentures disinfection might overcome issues present with chemical disinfection[13]. Anderson et al suggested that UV light dentures disinfection might notably lower environmental bacterial contamination, and thus this product is in high demand nowadays solely for this purpose[14].

Daily usage of chemical denture cleansers leads to acrylic resin bleaching and also very bad effect on soft resilient denture liners. Also, using household products like vinegar for denture cleansing has been highly doubtful and thus needs to be documented. It is widely recommended to use combination of mechanical and chemical methods for denture cleansing. Nevertheless, controversial outcomes have been seen in few trials when testing those procedures. Better results were seen in testing with either solutions or brushing or their combination[15].

Although several techniques were performed to disinfect dentures, no comparative study has been performed till date that could decide the most effective denture cleaning method. A properly cleaned prostheses contributes to good oral health and patient's quality of life. The dentist must be able to recommend a superefficient denture cleanser which is compatible to denture materials and safe for patient usage. Keeping in view, the present study was conducted to compare and

evaluate the efficacy of various commercially available chemical denture cleansing materials on the removal of tea, coffee and turmeric stains.

Materials and methodology

Following equipment and materials were used in this study. Elico SP150 UV /VIS Spectrophotometer (B-90, A.P.I.E., Sanathnagar, Hyderabad 500 018, A.P. India) (Fig.1).

Conventional heat cured (poly methyl methacrylate) denture base resin in powder and liquid form (DPI-Dental Products of India limited, Mumbai), Commercially available chemical denture cleansers (Clinsodent, Safeplus and Sodium Hypochlorite) (Fig.2).

Methodology

A commercially available denture base resin was selected as control for all samples. The manufacturer instructions were followed and the Poly methyl meth acrylate specimens were fabricated. For standardization of specimens a metallic block was fabricated from CAD-CAM technique. The metallic blocks had two parts; Base and Body. Four rectangular spaces of dimensions 9mm X 36mm X 2 mm were cut in central portion of the body.

Phase I

Preparation of the mould

A thin layer of petroleum jelly was applied on the inner surface of die slot created in the metallic block and base. The base and mould blocks were assembled with the help of glass slab. Modelling wax (Rolex Delhi India) was melted using a wax bath and poured into the mould space. Once the space was filled, it was covered with glass slab. Any discrepancy in the size and shape of the wax block was corrected by either pouring or eliminating wax and cooled. After 15 minutes the base and glass slab were removed. Any excess wax was carved out with wax knife. The completely hardened wax blocks were kept at room temperature for 5 minutes and were then invested in plaster to fabricate the Poly methyl meth acrylate resin samples. These wax blocks were invested in the denture flask using dental plaster following the manufacturer instructions for water/ powder ratio, mixing time and setting time. A mechanical vibrator was used to prevent air trapping during flasking. Dewaxing was done by keeping the flask in the boiling water.

Preparation of acrylic specimens for and recording prestained reflectance curve

The material used was conventional heat polymerized denture base material (DPI). A thin film of Cold mold seal was applied on the dental stone mould with help of a brush and allowed to dry. The polymer and monomer were mixed in ratio of 3:1 by volume (45 mg:15ml). Flasks were closed with the cellophane sheet in between them for trial closure in hydraulic press under 20 KN pressure. Excess of the material was trimmed using BP blade. The flasks were clamped and final closure was done under pressure of 20 KN for 30 min. The flask was immersed in water in an Acrylizer containing water at room temperature and processing was done according to manufacturer recommendations.

After the completion of the curing cycle, the flasks were allowed to bench cool to room temperature. After overnight bench cooling, cured specimens were carefully removed and deflasked. They were trimmed and polished using progressive grits of sand paper and buffs, finally ensuring that the dimensions of 9mm X 36mm X 2 mm were maintained. The samples were stored in distilled water for 24 hours so as to reduce the residual monomer content. Total 80 samples for pre stained, 80 samples for post stained and 20 samples for each type of denture cleanser were prepared (Fig.3).

The samples thus obtained were subjected to spectrophotometer analysis to record pre-stained reflectance values. Before recording these values, all the samples were treated with freshly prepared artificial saliva for 5-7 minutes for the formation of initial pellicle layer to simulate the oral condition. After that, the reflectance value of each sample was measured by using Elico SP150 UV Vis Spectrophotometer at different wavelength ranging from 380 to 740 nm by measuring the absorbance and transmittance of samples. The reflectance curve was obtained at different wavelength.

Phase II

Preparation of stain solutions

Preparation of Tea solution: 4 gm of TATA Premium Tea leaves were dissolved in 200 ml of boiling distilled water in a container and filtered using muslin cloth. The prepared solution was allowed to stand for 10 minutes.

Preparation of Turmeric solution: 4gm of Everest Turmeric powder of was dissolved in 400 ml of boiling distilled water in a container and filtered using muslin cloth. The prepared solution was allowed to stand for 10 minutes.

Preparation of Coffee solution: 4 gm of Nescafe coffee powder was dissolved in 1000ml of boiling distilled water in a container and filtered using muslin cloth. The prepared solution was allowed to stand for 10 minutes (Fig.4).

Phase III

Staining of the samples and recording post staining reflectance curve: the prepared 80 samples were stained for 1 hour in freshly prepared tea, coffee and turmeric solutions (Fig 6). The reflectance value of these stained samples at wavelength ranging from 380 to 740 nm were recorded using Elico SP 150 spectrophotometer by measuring the absorbance and transmittance value and another reflectance curve was obtained.

Phase IV

Immersion in denture cleansers and recording post cleansing reflectance curve: 20 samples were immersed in each commercially available denture cleansers Clinsodent, Safeplus and Sodium hypochlorite and normal water as control (Fig.7) and reflectance curve value was recorded.

Phase V

Following the Spectrophotometer analysis, the reflectance values were collected and reflectance curve was obtained and the data was statistically analysed by using one-way ANOVA and Tukey test (Fg.8, Fig.9, Table I and Table II).

Results

Clinsodent has a comparatively greater stain removal capability than Safe plus followed by Sodium hypochlorite and Control group i.e., distilled water respectively.

Discussion

Denture cleaning is an important aspect of reducing cross contamination and improving patient's oral health, denture longevity, and overall quality of life. The maintenance of appropriate denture hygiene is crucial not just for aesthetic reasons, but also for the patient's health and the prevention of oral malodor.

Plaque, calculus, and stains are attracted to denture base materials and denture teeth. Dentures, particularly denture bases made of acrylic resin, are rapidly colonized by oral endogenous bacteria and, subsequently, extraoral bacteria like Staphylococcus or members of the Enterobacteriaceae family.

Denture-related stomatitis and aspiration pneumonia, a life-threatening infection, can both be caused by this microbial reservoir. Denture plaque may operate as a reservoir for respiratory infections, allowing them to colonize the oropharynx more quickly in the elderly[16].

A variety of denture cleaning methods can be used to reduce denture plaque. These techniques can be based on mechanical, chemical, mechano-chemical or ultrasonic methods. Brushes, nailbrushes, magnetic stirrers, agitators, and sonic vibrators are examples of mechanical procedures.

Chemical approaches include soaking in either domestic (e.g. diluted sodium hypochlorite) or commercial solutions, exposure to ozonated water and microwave radiation. The use of an ultrasound generating transducer, such as the Digital Ultrasound Cleaner (CD-4820), in which an ultrasound generating transducer is built, which produces ultrasonic waves in the fluid by changing its size followed by change in an electrical signal oscillating at ultrasonic frequency. This causes compression waves to form in the tank's liquid, tearing it apart and leaving millions of microscopic 'voids' or partial vacuum bubbles behind (cavitation)[17].

Acrylic resins, which make up the foundation of complete and removable dentures, accumulate organic and inorganic stains and odours. Furthermore, as people age and their physical dexterity deteriorates, cleaning their dentures solely with a hand brush becomes increasingly difficult. As a result, denture cleansers are required to eliminate external stains and to extend the life of dentures by cleaning debris and bacteria formation on the acrylic resin surface.

Khajuria R et al[18] compared the performance of sodium hypochlorite and sodium perborate in removing stains from acrylic resin and found that both are equally effective in removing tea, turmeric, and coffee stains.

In his study to examine the performance of various denture cleansers in eliminating tea and paan stains Gopalkrishan. S et al [19]found that both sodium hypochlorite and Fittydent denture cleansers were efficient at removing stains from the denture surface and Fittydent was best for removal of stains in all post-cleansing stages.

Dogra S. et al[20] used a reflectance spectrophotometer to assess the efficacy of sodium hypochlorite and sodium perborate in removing stains from acrylic resins. They found that sodium hypochlorite and sodium perborate are both highly effective stain removers. However, when comparing the two, sodium perborate was more effective.

The effectiveness of seven denture cleansers on tea stain removal and their method of action on poly meth methyl acrylate acrylic resin were investigated by Jagger DC[21]. Denture cleansing products containing hypochlorite were shown to be the most effective at removing stains from denture base materials. Irregularities and porosities on the denture surface played a substantial impact in lowering the activity of denture cleaning agents, resulting in higher stain and plaque removal.

Lima et al[22] conducted research and found that most denture cleansers should be able to diminish biofilm deposition on denture surfaces. He also studied that whether the use of denture cleansers caused roughness on acrylic resin surface. He concluded that Sodium hypochlorite is more effective and decreases bacterial adhesion and biofilm formation on acrylic resins. In conclusion, the findings imply that the cleansers tested had no effect on the roughness of acrylic resin, but that the ability to decrease biofilm accumulation is dependent on the product employed.

Puri D et al[23] compared the effects of three commercially available denture cleansers on the surface color, surface roughness, and flexural strength of heat cure resin in a study. The changes in surface color of all denture base resins were within clinically acceptable ranges and were highest in Secure, followed by Fittydent, and lowest in Clinsodent denture cleansers. The change in surface

roughness was lowest in Fittydent denture cleanser, while Clinsodent, followed by Secure denture cleanser, showed the greatest change in surface roughness. All three-denture cleanser caused a considerable drop in flexural strength, with Secure denture cleanser showing the least decline followed by Fittydent and Clinsodent respectively.

Budtz-jogerson[24] did a study and discovered that immersing dentures in an alkaline peroxide solution was a safe and moderately effective way of cleaning dentures, whereas sodium hypochlorite cleaners were effective but should only be used once a week due to their bleaching impact.

In a study, Joseph[25] discovered that a cleanser containing sodium perborate was more successful in eradicating turmeric stains in both 20 minutes and 8 hours than a cleanser containing sodium hypochlorite.

In the present study, eighty samples of heat cure acrylic resin were prepared to examine and compare the efficacy of three different types of denture cleansers (clinsodent, Safeplus and Sodium hypochlorite) with water as control for removing tea, coffee, and turmeric stains. Testing of samples in the present study was carried out using a UV visible Elico SP 150 spectrophotometer. The reflectance values of the samples were measured, and the readings were then converted to obtain the reflectance curve.

ANOVA test showed the result to be statistically significant when three commercially available denture cleansers were taken into consideration. Also, on application of Turkey's HSD test, it was found that the results were statistically significant on comparison of Clinsodent, Safeplus, Sodium hypochlorite and Distilled water as denture cleansers.

1. Overall, the results showed that there was a difference in the efficacy of all three denture cleansers in removing tea, coffee, and turmeric stains from heat cure acrylic resins.
2. When the three denture cleansers were compared with water as control, it was found that the samples cleaned with water showed least reflectance value followed by sodium hypochlorite, followed by safeplus and clinsodent respectively.
3. Henceforth, within the limitations of the study it is concluded that to remove tea, turmeric and coffee stains from acrylic denture base material, clinsodent was found to be most effective, followed by safeplus, sodium hypochlorite and distilled water respectively.
4. Clinsodent effectively removed artificial saliva biofilm from acrylic samples and was successful in removing tea, turmeric and coffee stains.
5. Safeplus was also effective in removing artificial saliva biofilm from acrylic samples and was successful in removing tea, turmeric and coffee stains.
6. In comparison to Clinsodent and Safeplus, Sodium hypochlorite was effective in removing artificial saliva biofilm from acrylic samples and but was comparatively less effective in removing tea, turmeric and coffee stains.
7. Distilled water was barely helpful in removing artificial saliva biofilm from acrylic samples and was least effective in removing tea, turmeric and coffee stains.
8. It is further recommended that sodium hypochlorite cleaner is not intended for use on a regular basis with any prosthesis made of acrylic as it caused bleaching of denture surface.
9. The reliability of denture cleansers is also dependent upon a patient's capability to effectively use it.

Conclusion

Maintaining a good oral hygiene is a pre-requisite to overall good health and wellbeing of an individual. With older age, poor motor and sensory reflexes maintaining good hygiene becomes a challenge for denture wearers. Poor hygiene can be related to plaque formation, staining of dentures, bad odor, bad taste, poor aesthetics, accumulation of microorganisms causing mucosal irritation etc. The dentures of even healthy individuals must be considered as possible sources of pathogenic microorganisms. There are several oral hygiene techniques and products available to clean dentures. With all manufacturer's claiming their material to be of highest efficiency a prosthodontist is not able to recommend a single denture cleanser with complete confidence. So, the present in vitro study was conducted to compare the efficacy of commercially available denture cleansers namely Clinsodent, Safeplus and Sodium Hypochlorite for removing of tea, coffee and turmeric stains with distilled water as control for denture cleansers.

Within the limitations of present study, it was concluded that:

1. Clinsodent has a comparatively greater stain removal capability than Safeplus followed by Sodium hypochlorite and Control group i.e., distilled water respectively.
2. Immediate cleansing of dentures with running tap water after meal is strongly recommended.

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Lagends Figures and Tables

Figure 1: Elico SP 150 UV Visible Spectrophotometer

Figure 2 - Denture cleansers

Figure 3: Group A- 80 samples pre- stained- samples of conventional poly (methyl methacrylate) heat cured denture base resin

Figure 4: Preparation of solutions for staining of samples

Figure 5: 80 samples post- stained- samples of conventional poly (methyl methacrylate) heat cured denture base resin.

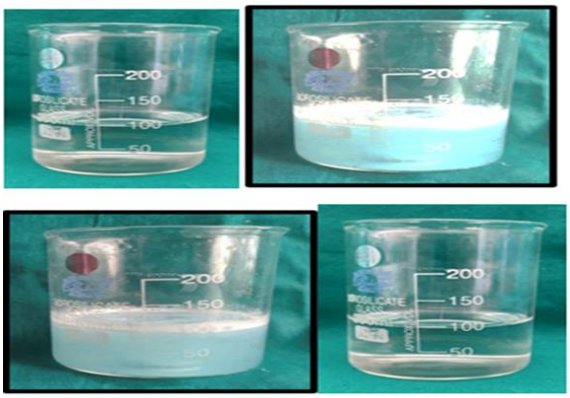

Figure 6: Preparation of Hypochlorite, Safeplus, Distilled water, Clinsodent Denture Cleansers

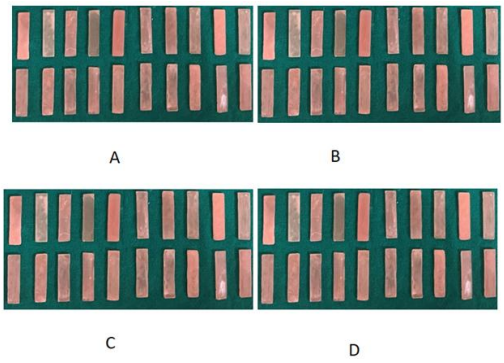

Figure 7: Samples after being exposed to Denture Cleanser A Distilled Water, B Clinsodent, C Safeplus, D Sodium Hypochlorite

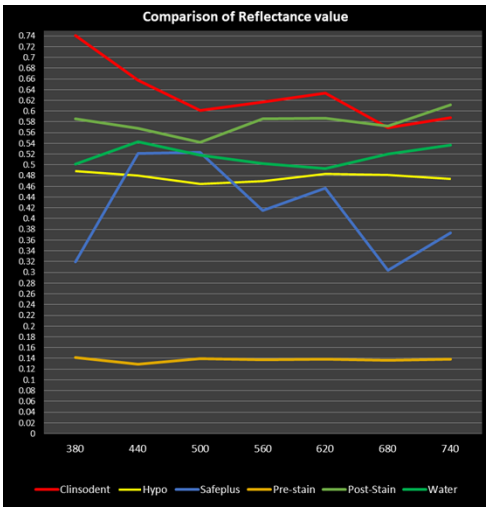

Figure 8: Curve depicts all the reflectance value of pre-stained, post- stained and three denture cleansers from 0 to 0.74 at wavelength 380 to 740 nm

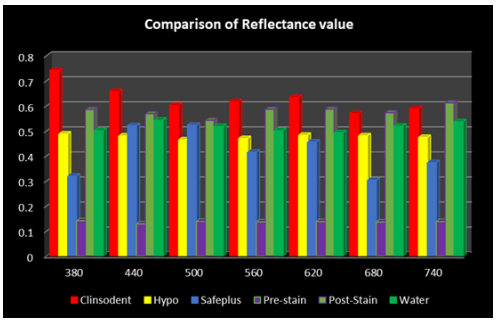

Figure 9: Bar chart representation the comparison of all reflectance value 0 to 0.8 of pre- stained samples, post-stained samples and three denture cleansers

Table 1: Determine the statistical difference between the groups ($p \leq 0.05$ – Significant, CI =95%)

SUMMARY	Count	Sum	Average	Variance		
Clinsodent	7	4.40734	0.62962	0.003267		
Sodium Hypo chlorite	7	3.3411	0.4773	0.000065		
Safeplus	7	2.9123	0.416043	0.007963		
Water	7	3.614	0.516286	0.000357		
380	4	2.04993	0.512483	0.030057		
440	4	2.20146	0.550365	0.005779		
500	4	2.10746	0.526865	0.00319		
560	4	2.00382	0.500955	0.007239		
620	4	2.06571	0.516428	0.006327		
680	4	1.87315	0.468288	0.013361		
740	4	1.97321	0.493303	0.008508		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.169719	3	0.056573	18.97516	0.0	3.159908
Columns	0.016246	6	0.002708	0.908189	0.510935394	2.661305
Error	0.053666	18	0.002981			

Table 2: The comparison between all three denture cleansers and level of significance ($p < 0.05$) among all of them

(I)Group	(J)Group	Abs. Mean Difference	Q critical Value	Significance
Clinsodent	Sodium Hypo chlorite	0.15232	0.066222	S
	Safeplus	0.213577	0.066222	S
	Water	0.113334	0.066222	S
Sodium Hypochlorite	Clinsodent	0.15232	0.066222	S
	Safeplus	0.061257	0.066222	NS
	Water	0.038986	0.066222	NS
Safeplus	Sodium Hypo chlorite	0.061257	0.066222	NS
	Clinsodent	0.213577	0.066222	S
	Water	0.100243	0.066222	S
Water	Clinsodent	0.113334	0.066222	S
	Safeplus	0.100243	0.066222	S
	Sodium Hypo chlorite	0.038986	0.066222	NS