Comparison of various methods of disinfecting acrylic dentures: Assessment of antimicrobial efficacy & dimensional changes

Rubina Gupta[1,*], Richa Aggarwal[2], Himanshu Aeran[3]

[1]Associate Professor, [2]Assistant Professor, Dept. of Dental Surgery, Muzaffarnagar Medical College, Uttar Pradesh, [3]Director Principal, Professor & Head, Dept. of Prosthodontics & Implantology, Seema Dental College & Hospital, Rishikesh, Uttarakhand

***Corresponding Author:**
Email: dr.guptarubina@gmail.com

Abstract

Aim: The aim of the study was to investigate different procedures to check for the most effective and most dimensionally accurate disinfection method for acrylic dentures.

Material and Method: Forty five edentulous patients wearing dentures were divided into three categories: Group I included disinfection with conventional microwave at 650 W for 3 mins twice a week, Group II disinfected their dentures by immersing in 0.2% clorhexidine gluconate solution for 30 mins twice a week and Group III used 100% White vinegar solution for immersion for 30 mins twice a week. The inter-molar distance, inter canine distance; the anterio-posteriro distance and the depth of the cast were measured with Digital Vernier calipers.

Result: Group III showed highest decline in number of bacterial colonies after 60 days followed by Group I. Least decline was seen in II. Highest dimensional changes was seen in Group I followed by Group II dentures.

Conclusion: Within the limitations of the study, it was concluded that all the three methods were effective for disinfection of denture while immersion in White vinegar was most dimensionally stable.

Access this article online

Website:
www.innovativepublication.com

DOI:
10.5958/2395-499X.2016.00028.9

Introduction

The microbial flora of the oral cavity is extremely diverse due to abundant nutrients, moisture, hospitable temperature and availability of surfaces to develop. The majority of these organisms pose no risk; however, a number of them cause serious infections. The most frequently identified microorganisms in the oral cavity are *Streptococcus* species, *Staphylococcus* species, *Escherichia coli* species, *Actinomyces* species, *Preptostreptococcus* species, *Pseudomonas* species, *Enterobacter* species, *Klebsiella pneumonia*, and *Candida* species.

With innovations in medical field, the population of adults older than 65 years has increased worldwide. With ageing, these adults experience a decrease in the immune response to infections, and an increase in physical impairment.[1] Adults thus lacking the appropriate manual dexterity are unable to maintain oral and denture appliances hygiene and become more susceptibility to opportunistic oral mucosal infections. This may be more evident among those residing in long-term care facilities and nursing homes.[2]

Denture and oral cleaning should be quick and easy to perform by patients and/or their caregivers. The cleaning procedures should also be efficient and economical, and comprise of regular oral care, denture hygiene, and removal of the dentures at night. These procedures can be combined with the administration of antifungal and antimicrobial agents in the case of severe and persistent mucosal infection.[3] Although the aforementioned methods seem to be effective, they are underused.

An early and classic study reported that denture base acrylic resins should preserve their physical and mechanical properties, be impermeable to oral fluids and resist the bacterial action and growth during clinical use.[4] The level of roughness of a resin can affect biofilm adhesion and staining, contributing to the rate of microbial colonisation on acrylic resin.[5] Thus, to facilitate denture cleaning and improving patient's comfort, laboratory polishing procedures should be directed to provide bases with a smooth and homogenous surface**.** But removable acrylic appliances have the potential for plaque accumulation due to surface porosities which causes increase bacterial activity. Accordingly, an unsatisfactory denture cleaning procedure will not efficiently remove the microorganisms entrapped in micropits and microporosities of the denture surface[6] leading to several diseases including denture stomatitis, aspiration pneumonia, and lung and gastrointestinal infections.[7] Poor oral and denture hygiene are usually the most common culprits in the development of denture stomatitis.[3]

Correct prosthetic use and daily hygiene are important factors for good oral health, greater longevity of the prosthesis, and health of supporting tissue. It was reported that daily hygiene has been essential to prevent oral mucosal inflammation and lesions. Nikawaetal suggested that appropriate control for denture plaque

was essential to the long-term usage of the maxillofacial materials.[8] The use of an effective denture cleaning method that removes microorganisms without causing surface damage to the denture base or oral soft tissue is desirable.

Dentures can be cleaned mechanically, chemically, and a combination of them. The most commonly used methods are the use of a brush with hot or cold water. But the use of toothpaste might scratch and cause irregularities on the surface of the dentures, which further facilitates the adherence of the microflora.

Keng and Lim found that plaque levels were significantly higher on the fitting surfaces of the maxillary and mandibular dentures than on the sites of polished surfaces.[9] But the oral mucosa in close contact with the denture (the denture's fitting surface) cannot be mechanically polished as it can change he close adaptation of the fitting surface with the oral mucosa. Thirdly, the effective removal of denture plaque by brushing requires a certain degree of manual dexterity which is commonly compromised in the elderly. In addition, the irregularities and porosities present on the acrylic resin surface may also contribute to penetration of microorganisms into dentures, making it difficult to clean them by brushing**.** Palenik and Miller have found that mechanical cleaning of dentures were insufficient for reducing the number of microorganisms on dentures and palate.[10]

Alternatively, easy to use and efficient methods for cleaning dentures and disinfecting to control denture stomatitis have been suggested, including the use of a standard microwave oven and immersion in chemical solutions. However, the effect of these procedures on the surface characteristics of denture base and the dimensional stability of the denture has not been completely evaluated.

Microwave irradiation is a simple, easy to use, effective, quick and inexpensive method for denture disinfection and sterilisation. Conventional microwave can be used for disinfecting dentures, thus making it easily accessible. Some studies have demonstrated the effectiveness of microwave irradiation as an alternative method for disinfection of denture base acrylic resins.[11,12] It does not alter the colour or smell of the dentures although it cannot be used if the appliances contain metal components**.** However, the short- and long-term effects of microwave use on denture materials are inconsistent and no agreement has been reached on an accepted standardised protocol for microwave oven therapy.

It is admitted that chemical disinfectants are more effective and simple to use than mechanical cleaning. Various household chemicals that are readily available can be used for this purpose. An ideal disinfectant should be readily available, cost-effective, have good antibiotic action, should remove inorganic/organic deposits and stains and does not cause dimensional and surface changes in the denture base. Andrucioli et al reported that the chemical methods were not routinely applied, either due to lack of information or knowledge about these methods, cost or lack of access, or non-availability of these products in the market.[13]

Chlorhexidine gluconate, a broad-spectrum antimicrobial agent has a 30- year history in dental medicine and is considered as the gold standard among new mouth rinse formulations due to its profound antibacterial and antiplaque activity. So we used it as the disinfectant in our study.

Although the white vinegar is not frequently used in dentistry as a disinfectant, it is preferred as a promising alternative disinfectant in several areas because of its low toxicity, low cost and easy availability.[14] White vinegar was frequently used in 50% and 100% concentrations to disinfect toothbrushes and acrylic resins. Komiyama et al. found 100% white vinegar to be most effective for Staphylococcus aureus, Streptococcus mutans, and Streptococcus pyogenes, and Candida albicans.[15] Hence, we used it as the other disinfectant in our study.

Material & Method

45 edentulous patients who had worn their dentures for 2–8 years were randomly selected. Medical history and oral examination were conducted to exclude the presence of local disorders. Patients under antimicrobial therapy and smokers were excluded from the study. The procedure was clearly explained to all participants who signed a consent form for the same.

Selected patients were randomly divided into three categories as follows.

- Group I: Patients were asked to disinfect their dentures with conventional microwave at 650 W for 3 mins twice a week
- Group II: Patients were asked to disinfect their dentures by immersing in 0.2% clorhexidine gluconate solution for 30 mins twice a week.
- Group III: Patients were asked to disinfect their dentures by immersing in 100% White vinegar solution for 30 mins twice a week.

After each disinfection process, the dentures were rinsed and stored in tap water.

On the first visit, bacterial swabs were collected from dry sterile cotton swab for all groups in mid palatal and alveolar ridge region for 30secs. These bacterial swabs were used to inoculate aerobic bacterial culture in blood agar media for 3 days at 37degrees. The species studied included Streptococcus species, Staphylococcus species & Escherichia coli species.

The patients were then asked to follow the specified disinfection regime for 60 days & Bacterial swabs were recollected using the above mentioned procedure.

Bacterial colonies were counted with the aid of light microscope after 72 hrs of culturing and multiplied to express them in Colony Forming Units(CFU)/ml.

For dimensional changes, the inter-molar distance (from tip of mesio-palatal cusp of left 1st molar to the tip of mesio-palatal cusp of right 1st molar), inter canine distance (from tip of cusp of left canine to the tip of cusp of right canine), the anterio-posteriro distance (from the incisive foramen to the middle point of posterior most end of dentures) and the depth of the cast (from the line joining the mesio-palatal cusps of the Ist molars straight down to the palate) were measured using a Digital Vernier calipers, with an accuracy of .001mm on first visit as well as after 60 days of disinfection. The distances were measured three times and mean was calculated.

Statistical Analysis

Statistical analysis for the present study was done by applying following formulas: Mean Value, Standard Deviation (S.D), Student 't' test and 'p' value – with 5% level of significance

Results

A total of 45 dentures were studied. The mean aerobic bacterial colony count was recorded for Group I, Group II & Group III on both visits. The readings of the first visit were considered as baseline & decline in the number of bacterial colonies indicated the effectiveness of the disinfection method. Group III showed highest decline in number of bacterial colonies (approx 72%) after 60 days followed by Group I (approx 60%). Least decline was seen in II (approx 53%). Thus all three methods were effective for disinfection of heat-cured denture bases.

The t test comparisons of the various dimensions showed highest dimensional changes in Group I. The inter-molar, inter-canine distance and depth showed significant increase when the dentures were disinfected with microwave heating. Also there was distortion of denture bases with some dimensions showing shrinkage & some showing expansion. On the other hand, the difference is clinically insignificant for Group III (immersion in white vinegar) & Group II (immersion in chlorhexidine) dentures, although the distortion was less in Group III.

Discussion

Dental prostheses are exposed to normal oral microbial flora such as viruses, bacteria, and fungi. Denture disinfection is a very important step to treat denture stomatitis, prevent cross-contamination between patients, and to remove bad odour and stains of acrylic resin dentures. This procedure should not cause harmful changes to denture base materials.

Oral problems related to poor hygiene of dentures indicate the needs to establish a disinfection protocol that is effective, clinically viable, inexpensive and easy to comply with. The available disinfection methods for complete dentures are still controversial because they might alter some material properties like color, hardness, roughness and dimensional stability.

Nishi et al. reported that daily soaking of dentures in a denture cleanser was effective method for reducing the quantities of microorganisms adhering to dentures.[16] The guidelines outlined by the American College of Prosthodontics recommend that dentures should be cleaned daily by soaking and brushing.[17] However, denture wearers who are with limited motor capacity and brushing their dentures may be difficult for them.

Chemical disinfection of dentures is commonly achieved by soaking it in an alkaline solutions, sodium hypochlorite, aqueous formaldehyde, antibacterial mouthwashes or enzymatic solutions. More recently, microwave irradiation also being considered as one of the method of denture sterilization/disinfection instead of chemical solutions.

In the present study, various methods of disinfection of acrylic resin dentures (conventional microwave at 650 W for 3 mins twice a week, by immersing in 0.2% clorhexidine gluconate solution for 30 mins twice a week and by immersing in 100% White vinegar solution for 30 mins twice a week) have been evaluated and their effects on the dimensional stability of the denture have been studied.

It was reported that MW disinfection is easy, effective and quick method, thus advantageous for some patients. The results of this study revealed microwave disinfection to be an effective method for disinfection of dentures. This is in accordance with previous studies that reported MW irradiation is an effective method to disinfect the acrylic resins.[18] with or without water bath.[19] Thomas and Webb found that after microwaving dentures for 10 min at 604 W, some measurements showed significant contraction or expansion but reduced exposure (6 min at 331 W) caused much smaller changes.[20] MW irradiation at 650w for 3 was found to be most effective method[21] and hence used in the present study.

The studies on the effect of microwave disinfection methods on dimensional stability of acrylic resin showed conflicting results. In the present study, dentures with microwave disinfection showed linear dimensional changes. This is in accordance with various studies that reported dimensional changes with microwave disinfection[21-24], while others did not report any change in dimensional stability.[25,26] This might be due to the use of different materials and methods to measure distortion and irradiation protocols (power and time). Our results are in agreement with those of Nirale et al. who found that microwave disinfection led to increased shrinkage of denture bases.[27]

The main results of this study showed that microwave disinfection produced significant changes in dimensional stability of denture bases. Hence, chemical disinfection seems to be a safer method of disinfecting dentures in comparison with microwave irradiation, as disinfection by microwave irradiation causes alteration

with regards to physical properties such as changes in dimensional stability.

CHX, a cationic bisbiguanide [1,6-di (4-chlorophenyl-diguanido) hexane] agent with a broad antibacterial spectrum (Gram-negative and Grampositive), some virus and antifungal activities and with low mammalian toxicity was first described in 1954. It is also biocompatible with oral tissues and is widely acknowledged as an extremely effective antiplaque and antigingivitis agent. It has been studied mostly in mouth-rinse formulations and is safe and effective. Chlorhexidine is not sporicidal and hence considered an intermediate-level disinfectant. Effectiveness of 0.2% on 0.12% CHX in reducing the clinical parameters were proved to be identical. Hence, 0.2% concentration is used in this study which is most commonly used concentration in mouthwashes.[28] We found it to be least effective out of the studied methods though clinically insignificant dimensional changes were observed. Though various studies found it to be most effective with rapid activity & found it to be a valid alternative for the disinfection of acrylic resin.

In the present study, White vinegar 100% was found to be the most effective agent with almost negligible dimensional changes. Similarly Yildirim-Bicer et al[21] & da Silva et al[29] found it to be the most effective agent against tested organisms. This agent is cost-effective and easy to access and it may be appropriate for house hold use. However, white vinegar is relatively new in dentistry and may be unknown by many clinicians. Further studies determining all of the effects, including the biocompatibility or toxic effects of white vinegar, may increase clinicians' awareness about its antimicrobial capacity, and it might also be introduced to other fields of dentistry, such as root-canal treatment.

Conclusion

Within the limitations of the study, it was concluded that the most effective and accurate method of disinfection of acrylic dentures is immersion in 100% white vinegar. Chlorhexidine showed least reduction in bacterial count and some dimensional changes. Microwave irradiation although was good disinfectant showed highest dimensional changes.

The limitation of this study was that this study evaluated the effect on only one denture base material. In addition, only one variety of microwave irradiation protocol and one type of concentration of chlorhexidine and white vinegar disinfectant were used for disinfecting the samples. Future studies are needed to evaluate the effect of various types of disinfection methods on different denture base and relined material with different concentration and disinfection protocols.

References

1. Gasparoto TH, Vieira NA, Porto VC et al.: Aging exacerbates damage of systemic and salivary neutrophils from patient presenting Candida-related denture stomatitis. Immunity Ageing 2009;6:3.
2. Vigild M.: Dental caries and the need for treatment amongst institutionalised elderly. Community Dent Oral Epidemiol 1989;17(2):102–105.
3. Webb BC, Thomas CJ, Willcox MDP et al.: Candida-associated denture stomatitis. Aetiology and management: a review part 3.Treatment of oral candidiasis. Aust Dent J 1998;43(4):244–249.
4. Spencer HR, Gariaeff P.: The present status of vulcanite versus plastics as a base plate material. Contact Point 1949;27:263–267.
5. Berger JC, Driscoll CF, Romberg E, Luo Q, Thompson G. Surface roughness of denture base acrylic resins after processing and after polishing. J Prosthodont 2006;15:180–186.
6. Budtz-Jorgensen E. Materials and methods for cleaning dentures. J Prosthet Dent 1979;42:619–623.
7. Furukawa KK, Niagro FD., Runyan DA., and Cameron SM.: Effectiveness of chlorine dioxide in disinfection on two soft denture liners. The Journal of Prosthetic Dentistry, 1998;80(6):723–729.
8. Nikawa H., Chen J., Hamada T., Nishimura M., and Polyzois G.: Candida albicans colonization on thermal cycled maxillofacial polymeric materials in vitro. Journal of Oral Rehabilitation, 2011;28(6):526–533.
9. S. Keng and M. Lim: Denture plaque distribution and the effectiveness of a perborate-containing denture cleanser. Quintessence International, 1996;27(5):341–345.
10. Palenik CJ and Miller CH.: In vitro testing of three denture cleaning systems. The Journal of Prosthetic Dentistry, 1984;51(6):751–754.
11. Webb BC, Thomas CJ, Harty DWS et al. Effectiveness of two methods of denture sterilization. J Oral Rehabil 1998;25(6):416–423.
12. Polyzios GL, Zissis AJ, Yannikakis SA. The effect of glutaraldehyde and microwave disinfection on some properties of acrylic denture resin. Int J Prosthodont 1995;8(2):150–154.
13. Andrucioli MC., deMacedo LD., Panzeri H., Lara EG., and Paranhos HD.: Comparison of two cleansing pastes for the removal of biofilm from dentures and palatal lesions in patients with atrophic chronic candidiasis. Brazilian Dental Journal, 2004;15(3):220–224.
14. daSilva FC, Kimpara ET.,Mancini MN., Balducci I., Jorge OC., and Koga-Ito CY.: Effectiveness of six different disinfectants on removing five microbial species and effects on the topographic characteristics of acrylic resin. Journal of Prosthodontics, 2008;17(8):627–633.
15. Komiyama EY., Back-Brito GN., Balducci I., and KogaIto CY.: Evaluation of alternative methods for the disinfection of tooth brushes. Brazilian Oral Research, 2010;24(1):28–33.
16. Y. Nishi, K. Seto, Y. Kamashita, C. Take, A. Kurono, and E. Nagaoka.: Examination of denture-cleaning methods based on the quantity of microorganisms adhering to a denture. Gerodontology, 2012;29(2):e259–e266.
17. D. Felton, L. Cooper, I. Duqum et al.: Evidence-based guidelines for the care and maintenance of complete dentures: a publication of the American College of Prosthodontists. Journal of Prosthodontics, 2011;20(1):S1–S12.
18. K. H. Neppelenbroek, A. C. Pavarina, D. M. Palomari Spolidorio, E. M. Sgavioli Massucato, L. C. Spolidorio, and C. E. Vergani.: Effectiveness of microwave disinfection of complete dentures on the treatment of Candida-related denture stomatitis. Journal of Oral Rehabilitation, 2008;35(11):836–846.

19. N.H. Kassab, E.A. Mustafa, and R.H. Hasan: Antifungal effect: comparison of commercial denture cleansers and microwave energy. Al-Rafidain Dental Journal, 2009;9(1):4–31.
20. Thomas C, Webb B (1995) Microwaving of acrylic resin dentures. Eur J Prosthodont Restor Dent 3:179–182.
21. Yildirim-Bicer AZ., Peker I., Akca G., and Celik I.: In Vitro Antifungal Evaluation of Seven Different Disinfectants on Acrylic Resins. BioMed Research International, June 2014:1-9.
22. Sartori EA, Schmidt CB, Walber LF, Shinkai RS. Effect of microwave disinfection on denture base adaptation and resin surface roughness. Braz Dent J 2006;17:195-200.
23. Pavan S, Arioli Filho JN, Dos Santos PH, Mollo Fde A Jr. Effect of microwave treatments on dimensional accuracy of maxillary acrylic resin denture base. Braz Dent J 2005;16:119-23.
24. Seo RS, Vergani CE, Pavarina AC, Compagnoni MA, Machado AL. Influence of microwave disinfection on the dimensional stability of intact and relined acrylic resin denture bases. J Prosthet Dent 2007;98:216-23.
25. Polyzois GL, Zissis AJ, Yannikakis SA. The effect of glutaraldehyde and microwave disinfection on some properties of acrylic denture resin. Int J Prosthodont 1995;8:150-4.
26. Consani RL, Iwasaki RY, Mesquita MF, Mendes WB, Consani S. Effect of repeated simulated disinfections by microwave energy on the complete denture base adaptation. Open Dent J 2008;2:61-6.
27. Nirale RM, Thombre R, Kubasad G (2012) Comparative evaluation of sodium hypochlorite and microwave disinfection on dimensional stability of denture bases. J Adv Prosthodont 4:24–29.
28. Rath SK. & Singh M.: Comparative clinical and microbiological efficacy of mouthwashes containing 0.2% and 0.12% chlorhexidine. Dent Res J. 2013;10(3):364–369.
29. daSilva FC, Kimpara ET.,Mancini MN., Balducci I., Jorge OC., and Koga-Ito CY.: Effectiveness of six different disinfectants on removing five microbial species and effects on the topographic characteristics of acrylic resin. Journal of Prosthodontics, 2008;17(8):627–633.