the Journal of CONTEMPORARY DENTAL PRACTICE
www.thejcdp.com
Volume 1 Number 2 Winter Issue, 2000

Denture Hygiene: A Review and Update

Kenneth Shay, DDS, MS

Abstract

Growth in the aging population has resulted in an increasing number of older persons requiring dentures. The microporous surfaces of an acrylic denture provide a wide range of environments to support microorganisms that can threaten the health of a physically vulnerable patient. The maintenance of denture prostheses is important for the health of patients and to maintain an esthetic, odor-free appliance.

Mechanical, chemical, and a combination of mechanical and chemical strategies are available to patients to facilitate denture hygiene. Brushing is an ineffective method of denture disinfection. Household bleach or vinegar are effective as are the commercial, effervescent products sold for denture soaking. A new denture cleaner contains silicone polymer that provides a protective coating for dentures as a final step in the cleaning process. The coating helps to minimize the adhesion of accretions to the denture throughout the day until the next cleaning.

Dental professionals must have a current knowledge of denture cleansing strategies in order to maximize the service offered to denture patients.

Keywords: Denture odor, dental hygiene, denture maintenance, esthetics, silicone polymer, ultrasonication, chemical cleansing, mechanical cleansing.

Introduction

©University of Sheffield - DERWeb Project

Complete dentures are the most common treatment for total loss of teeth in a dental arch. Although the prevalence of total tooth loss continues to decline among adults in the United States, population shifts have resulted in a sustained — even slightly increasing— demand for complete dentures.[1] Despite the fact that dentists are able to offer their patients an impressive array of services for preserving, restoring, and enhancing the natural dentition, there continues to be a widespread need for oral health professionals to provide excellent complete denture services. An essential component of complete denture service is patient education about denture hygiene.

©University of Sheffield - DERWeb Project

Preservation of some or much of the dentition into later adulthood has become increasingly common in industrialized nations in the second half of the Twentieth Century.[2] Tooth loss in any adult population is highly likely to increase as the population ages, because the factors that lead to the loss of teeth—dental caries, loss of periodontal support, a history of dentoalveolar trauma, a history of dental care—are additive over time. For this reason, rates of complete tooth loss are customarily highest in the oldest age groups. For example, over 70% of edentulous persons in the United States are over age 65.[3] Yet the degree of increasing tooth loss with advancing age is declining. In the United States, over two-thirds of adults over age seventy-five were fully edentulous in 1957, but by 1993, fewer than 40% of Americans in New England over age 75 years had lost all of their teeth.[4]

The Twentieth Century has also seen unprecedented shifts in the age distribution of the populations of industrialized nations. In the United States, approximately 3% of the population (about 3 million people) were over the age of 65 years in 1900. One hundred years later, over 13% of the population—more than 37 million Americans—have already celebrated their 65th birthdays.[5] This trend is most notable in the segment of the population over age 85, which has increased by a factor of more than 22 since the turn of the century, to nearly 4 million individualstoday. The dramatic growth of the proportion of the population living into the seventh, eighth, and ninth decades and beyond has coupled with the age-correlated nature of tooth loss. The result is a continued growth in the number of older persons requiring replacement dentitions, even as the proportion of older people requiring dentures has declined.[6] This trend has been predicted to continue into the coming decade.[1]

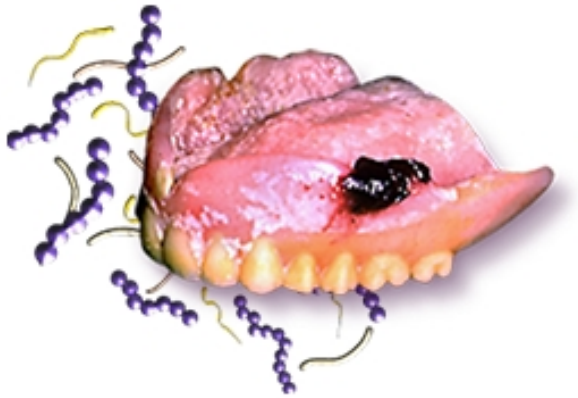
Chronic diseases that preferentially affect the elderly such as arthritis and diabetes are experienced with greater frequency, greater severity, and more often in conjunction with other disorders with advancing age. The same is true of tooth loss. Care of dentures and the mucosal tissues of the edentulous mouth can be important for overall health, especially in older persons. In addition, there may be greater social consequences of mouth malodor due to unclean oral prosthesis for someone whose dietary intake is strongly linked to socialization, such as an older person who attends a senior activities center for meals. Unclean dentures causing or contributing to mucosal disease and/or impairment in eating, therefore, may have a more profound effect on a frail elder than on a younger, healthier person.

Simply stated, care and cleaning of dentures is more than a strictly esthetic concern in the sizable and growing majority of denture patients who are of advanced age. This article is intended to provide members of the dental team with a review, comparison, and update of the strategies that are commonly employed for keeping removable oral prostheses clean.

Denture Debris

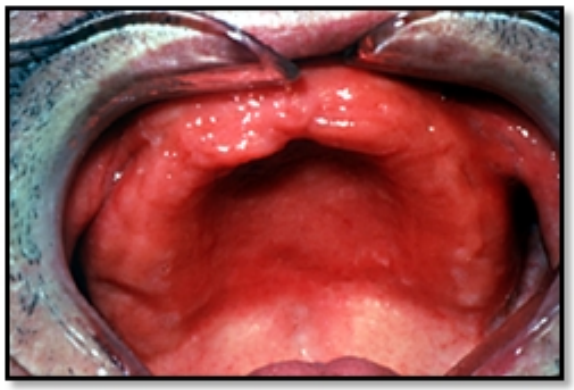
Every surface in the oral cavity, natural or synthetic, becomes covered within about 30 minutes with a 0.5-1.5 µ-thick precipitate of salivary glycoprotein and immunoglobulin that is termed "pellicle."[7,8,9] The pellicle in turn provides a substrate to which oral debris (such as mucin, food particles and desquamated epithelial cells) and microorganisms (bacteria and fungi) readily adhere.

Certain adherent bacteria and fungi convert materials such as sucrose and glucose in the oral environment into a protective plaque covering under which they can thrive and proliferate further.[10] This process is favored when salivary flow is impaired by disease or, more commonly, as a side effect of medications. In the absence of an adequate amount of saliva, less antimicrobial action will be available to counter the activity and proliferation of microorganisms.[11]

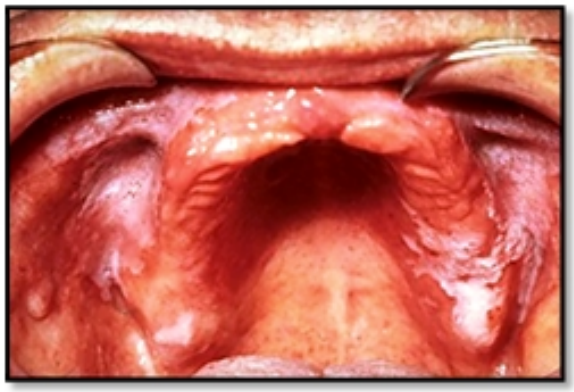


Adherence of microorganisms and debris is also favored by rough or otherwise irregular surface topography. Surface irregularities provide an increase in surface area and an expansion in the number of niches not readily cleansed by actions of the tongue or other orofacial musculature. This is a particular concern in the case of oral appliances fabricated out of methacrylate resin. Despite an outwardly smooth appearance, these appliances have a pockmarked surface when viewed under microscopic magnification.[12] This is due to bubble formation from unpolymerized monomer in the course of denture processing. Increased tendency for undesirable deposits is similarly observed when a chemically polymerized and rather porous chair side reline material has been applied to a denture surface. This occurs to a greater degree with over-the-counter, insoluble home reliner materials that are even more porous and generally far less smooth than processed and polished acrylic resin.

The fungal organisms that are most commonly associated with denture plaque are of the genus Candida. These yeasts are present in the saliva of a majority of denture wearers and display an affinity for adherence to methacrylate resin.[13] They are particularly effective at populating the "craters" formed by an intersection of a monomer bubble with the polished surface of the acrylic resin from which they are difficult to eradicate.[13]

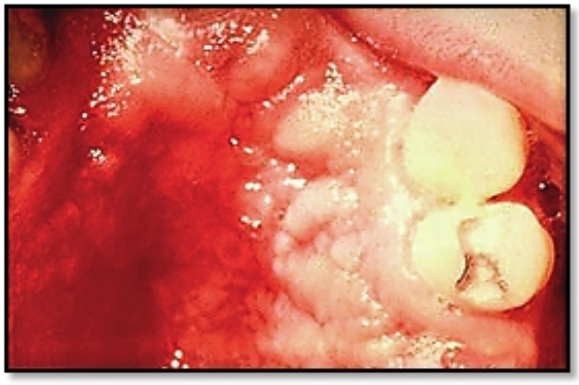


Courtesy of Dr. Kenneth Shay, Section Chief
Dental Geriatrics, Ann Arbor VA Medical Center



©Dr. Mike Martin, University of Liverpool - DERWeb Project
Chronic atrophic candidosis is seen on the maxillary oral mucosa associated with denture wearing. Note the presence of chronic pseudomembraneous candidosis

Multiple innocuous and pathogenic bacterial varieties have been identified in denture plaque, including S. aureus, P. aeruginosa, E. coli, K. pneumoniae, alpha strep., beta-strep., Group D strep., and assorted gram (-) rods.[14] Species of fusobacteria, which excrete volatile sulfur compounds associated with halitosis, have been identified as populous in denture plaque.[15]



©University of Sheffield - DERWeb Project
Denture induced hyperplasia characterized by severe inflammation of the palatal gingivae and possibly a fungal overgrowth.

The oral deposits and microorganisms that adhere to a dental appliance bring about several undesirable effects. First, the adherent material itself is unesthetic in appearance and unpleasant in terms of tactile sensation, taste, and odor. Because of the process of accommodation that sensory receptors undergo, the person with an unclean denture is likely unaware of the unpleasant smell and taste of the prosthesis, but gustatory experiments have confirmed impairment in taste and smell perception of external stimuli under circumstances of poor denture hygiene.[16]

Second, there are problems posed by the shear magnitude of the microbial population supported by unclean dentures. Denture plaque serves as a source of infectious oral material available for aspiration, particularly in persons with limited salivary flow.[17] Metabolic by-products and exotoxins in the deposits can be irritating to oral tissues.[18] Denture plaque, like the more familiar deposits on teeth, can also become calcified if not removed thoroughly and regularly. As with teeth, the surface of the mineralized calculus provides an even more hospitable surface for further plaque accretion. Calculus is also readily stained by tobacco, tea, coffee, certain medications (particularly iron supplements), and numerous other ingested materials.[10]

Removal of Oral Debris

Two major approaches are generally recommended to patients for the removal of material from dentures. Dentures can be cleaned mechanically, chemically, or through a combination of these.

The most familiar mechanical method for denture cleaning is the use of a brush in the presence of either hot or cold water. There are brushes specifically designed and sold for this purpose.

Toothbrushes and nailbrushes are also effective in removing gross material. Patients should be cautioned to always perform this sort of cleaning over a towel or over a sink in which several inches of water are standing, in order to minimize the possibility of damaging a dropped denture.[19] Patients who are limited in the use of one arm or hand due to stroke or amputation can benefit from nailbrushes that adhere to a countertop with suction cups. Such products can be obtained from suppliers for rehabilitation services. These suppliers also offer materials that will make the handle of a denture brush larger and easier to grip, although dental offices can usually achieve the same result using self-cure acrylic.

A less common but incomparably more effective mechanical approach to denture cleaning is through the use of a table-top ultrasonic cleaner. Gwinnett and colleagues demonstrated in several different ways effective disinfection of inoculated dentures through the use of ultrasonic treatment in a water bath, as well as in baths of various antiseptic and detergent agents.[20] In contrast, microbiologic assays and scanning electron microscopic images demonstrate that use of a denture brush with water is ineffective at removing an unacceptably large proportion of adherent microorganisms.[13,21] Small ultrasonic units are available for under $100, but utilization is extremely limited due to the lack of both professional and lay knowledge of this approach and the daunting startup cost (compared to a few dollars for a box of cleansing tablets). Ultrasonic cleaning makes sense in an institutional environment such as a nursing home or hospital. Patients' dentures can be placed in cleaning solution and sealed into plastic bags or secure cups prior to ultrasonication. This technique will ensure effective cleansing, preservation of owner identification, and maintenance of infection control.

Chemical methods for cleaning dentures include soaking in a household solution, soaking in a commercial solution, exposure to oxygen through air-drying, and microwave radiation. The most common household solution is bleach (sodium hypochlorite), diluted 1:10 in tap water. This concentration is adequate for killing adherent organisms but will be ineffective against calculus build-up and stain.[14] Addition of a teaspoon of calcium-chelating dishwasher detergent ("Calgon"®) to a cup of the diluted bleach solution has been advocated as a means for controlling calculus and the

stains associated with it.[22] A disadvantage of bleach is that metallic elements of removable partial dentures acquire a tenacious black stain after soaking in the bleach solution for more than 10 minutes daily.[10]

The use of vinegar (acetic acid solution) was evaluated by Basson and others who found it effective at killing adherent microorganisms although less effective than bleach solution.[23] One advantage of vinegar over bleach is that inadequate rinsing after soaking in vinegar does not result in mucosal damage (photo).

Neither solution has a pleasant odor. As a result, some patients choose to soak their prostheses in certain mouthwash products due to their more desirable odor, flavor, and the antibacterial claims of their manufacturers. The efficacy of the active ingredients of mouthwashes against prosthesis plaque organisms has not been reported, and the property of acrylic resin to resist absorbing taste prevents the flavor of the mouthwash from being acquired.

Soaking dentures in nystatin antifungal suspension has been empirically suggested as a useful adjunct in the management of denture stomatitis. Banting and colleagues found that a 10% dilution of 1:100,000 suspension of nystatin was no more effective than distilled water in reducing organisms on the denture surface, establishing that there is no basis for this rather expensive approach to denture cleaning.[24]

The dominant approach to denture cleansing in the United States is through the use of an effervescent commercial denture cleansing product dissolved in water. Industry estimates are that close to 80% of persons with a denture use one of these products at least weekly. Specific ingredients and their proportions vary, but the dominant commercial formulations include compounds for oxidizing (usually an alkaline perborate), effervescing (perborate and/or carbonate), and chelating (EDTA).[10] Detergent, color, and fragrance agents are present as well. The formulations are effective at essentially sterilizing a prosthesis when used overnight; they achieve a 99% kill rate of most organisms in the recommended 10- to 20-minute soaking time. McCabe and colleagues reported that the effects of alkaline peroxide solutions were enhanced by using water at a temperature of 50° Celsius.[25]

The alkaline peroxide solutions may not be compatible with certain permanent or temporary resilient lining materials, however, and patients should be cautioned to minimize the duration they soak soft-line dentures.[26] Proteolytic enzyme-containing cleansing agents designed to break down protective mucin deposits on dentures[27] have received some study outside the United States. However, Nakamoto[28] and colleagues concluded that their efficacy against Candida was inferior to the action of alkaline peroxide compounds.

A component of commercial denture cleanser that has just recently been introduced to the United States is a silicone polymer to which oral bacteria are unable to adhere. The new component floats on the surface of the denture bath, and when the denture is removed from the solution, a thin layer (constituting 0.1-0.8 mg) of the material coats all surfaces of the prosthesis. The material will not rinse or rub off but is slowly lost over the day. All human and animal trials have demonstrated that the material is inert and the volume ingested is two orders of magnitude beneath the established maximum daily dosage.[29] The addition of silicone polymer to a denture cleanser product signals a welcome new approach to denture care; the idea that "prevention of oral disease" does not stop when the natural dentition is lost.

Webb and colleagues investigated the use of microwave radiation to disinfect denture acrylic resin.[30] They found the method to be effective at significantly reducing the number of cultivable organisms on the dentures, but non-viable organisms and their by-products still present after exposure to the radiation will still able to elicit an unwanted host response. For this reason, the use of a microwave should be preceded by some method of debridement such as ultrasonication or thorough brushing.

Most chemical means of disinfection is accomplished through exposure of the organisms to oxygen tension levels greater than oxygen tension levels in the mouth. This can also be accomplished by allowing a denture to air dry overnight, thereby, effectively killing yeasts and many bacterial species as well.[31] Air-drying does not have widespread acceptance as a denture cleaning technique for two reasons. First, merely drying an unclean denture will make the adherent material stick ever more tightly even as it fails to remove microbial surface antigens and exotoxins. Therefore, air drying, like microwave radiation, must be preceded by mechanical debridement of the denture surface. Second, dentists have historically been told that air drying an acrylic denture will distort its contours. This is a widespread but inaccurate belief. It has a limited basis in fact derived from old studies on very early, and now antiquated, acrylic formulations.

Summary

Unclean dentures represent both an esthetic and a health concern for the person using them. Dental staff need to have a working knowledge of the range of techniques and materials that are available for cleaning dentures and keeping them in a hygienic state so that they are able to instruct patients appropriately. Brushing alone, with or without a dentifrice, is an inadequate approach for controlling denture plaque. Less than one hour soaking in a dilute bleach solution or one of the

commercial effervescent products are both effective means for cleaning dentures. Ultrasonication is effective but not broadly used. Microwave treatment and air drying effectively kill organisms but may not eradicate antigenic irritants. Interference with bacterial adherence through daily application of a silicone polymer to the surface of the denture is a promising recent development in denture cleansing technology.

References

1. Douglass CW, Gammon MD, Atwood DA. Need and effective demand for prosthodontic treatment. J Prosthet Dent 1988 59:94.
2. Ettinger RL. Managing and treating the atrophic mandible. J Am Dent Assoc. 1993 124 234.
3. Miller AJ, Brunelle JA, Carlos JP et al. Oral health of United States adults: the national survey of oral health In U.S. employed adults and seniors: 1985-86. National findings. National Institutes of Health 1987. Publication NIH-87-2868.
4. Douglass CW, Jette AM, Fox CH et al. Oral health status of the elderly In New England. J Gerontol: Med Sci 1993 48:M39.
5. Berkey DB. Berg RG. Ettinger RL. Mersel A. Mann J. The old-old dental patient: the challenge of clinical decision-making. [Review] [37 refs] Journal of the American Dental Association. 127(3):321-32, 1996.
6. Gordon SR. Older adults: demographics and need for quality care. [Review] [32 refs] Journal of Prosthetic Dentistry. 61(6):737-41, 1989.
7. Skjorland KK, Rykke M, Sonju T. Rate of pellicle formation in vivo. acta Odontol Scand 1995 53:358.
8. Carlen A, Borjesson AC, Nikdel K, et al. Composition of pellicles formed in vivo on tooth surfaces in different parts of the dentition, and in vitro on hydroxyapatite. Caries Res (1998) 32:447.
9. Amaechi BT, Higham SM, Edgar WM, et al. Thickness of acquired salivary pellicle as a determinant of the sites of dental erosion. J Dent Res 1999 78:1821.
10. Abelson DC. Denture plaque and denture cleansers: review of the literature. Gerodontics 1985 1:202.
11. Mandel ID. The role of saliva in maintaining oral homeostasis. J Amer Dent Assoc 1989, 119:298.
12. Kulak Y, Arikan A, Albak S et al. Scanning electron microscopic examination of different cleaners: surface contaminant removal from dentures. J Oral Rehabil 1997 24:209.
13. Shay, K.; Renner, R.P.; and Truhlar, M.R. Oropharyngeal candidosis in the older patient. J. Amer. Geriatr. Soc., 1997; 45:863-870.
14. Saunders TR, Guillory VL, Gregoire ST et al. The effect of bioburden on in-depth disinfection of denture base acrylic resin. CDA Journal 1998 26:846.
15. Chan ECS, Iogovaz, I, Silbo R, et al. Comparison of two popular methods for removal and killing of bacteria from dentures. J Canad Dent Assoc 1991 57:937.
16. Hyde RJ. Feller RP. Sharon IM. Tongue brushing, dentifrice, and age effects on taste and smell. Journal of Dental Research. 60(10):1730-4, 1981.
17. Loesche WJ. Bromberg J. Terpenning MS. Bretz WA. Dominguez BL. Grossman NS. Langmore SE. Xerostomia, xerogenic medications and food avoidances in selected geriatric groups. Journal of the American Geriatrics Society. 43(4):401-7, 1995.
18. Tarbet WJ. Denture plaque: quiet destroyer. J Prosthet Dent 1982 48:647.
19. Jagger DC, Harrison A. Denture cleansing—the best approach. Br Dent J 1995 178:413.
20. Gwinnett AJ and Caputo L. The effectiveness of ultrasonic denture cleaning: a scanning electron microscope study. J Prosthet Dent 1983 50:20.
21. Dills SS, Olshan AM, Goldner S et al. Comparison of the antimicrobial capability of an abrasive paste and chemical-soak denture cleaners. J Prosthet Dent 1988 60:467.
22. Glass RT, Belobraydic KA. The dilemma of denture contamination. Okla Dental Assoc J 1990, 81(2):30.
23. Basson NJ, Quick AN, Thomas CJ. Household products as sanitising agents in denture cleansing. J Dent Assoc S Africa 1992 47:437.
24. Banting DW, Greenhorn PA, McMinn JG. Effectiveness of a topical antifungal regimen for the treatment of oral candidiasis in older, chronically ill, institutionalized, adults. J Canad Dent Assoc 1995 61:199.

25. McCabe JF, Murray ID, Kelly PJ. The efficacy of denture cleansers. Eur J Prosthodont Restor Dent 1995 3:203.
26. Davenport JC, Wilson HJ, Spence D. The compatibility of soft lining materials with immersion denture cleansers. Br Dent J 1986 161:13.
27. Odman PA. The effectiveness of an enzyme-containing denture cleanser. Quint Int 1992 23:187.
28. Nakamoto K, Tamamoto M, Hamada T. Evaluation of denture cleansers with and without enzymes against andida albicans. J Prosthet Dent 1991 66:792.
29. Goffin G. Efficacy of New Denture Cleansing System. Int Dent Rev 1998 2:7.
30. Webb BC, Thomas CJ, Harty DW, et al. Effectiveness of two methods of denture sterilization. J Oral Rehabil 1998 25:416.
31. Stafford GD, Arendorf T, Huggett R. The effect of overnight drying and water Immersion on candidal colonization and properties of complete dentures. J Dent 1986 14:52.

About the Author

Kenneth Shay, DDS, MS

Corresponding Author-

Dr. Shay is currently the Director of the Geriatrics and Extended Care Service Line for the VA health services of lower Michigan, northern Ohio, Indiana, and eastern Illinois. He is also the section Chief for Dental Geriatrics at the Ann Arbor VA Medical Center and Adjunct Associate Professor of Dentistry at the University of Michigan School of Dentistry. He serves as the Co-Director for Dentistry of the University of Michigan Interdisciplinary Geriatrics Fellowship. He is a former Chair of the Federation of Special Care Organizations in Dentistry, a past President of the American Society for Geriatric Dentistry, and was the founding Director of the Wisconsin Geriatric Education Center. He serves as an Associate Editor for the journals Special Care Dentistry and Gerodontology, and is a Fellow of the American Society for Geriatric Dentistry, of the Gerontological Society of America, and of the American College of Dentists. For nearly twenty years he has limited his practice of dentistry to caring for very old adults who have significantly debilitating physical and cognitive disorders.

e-mail: Ken.Shay@med.va.gov
phone: 734-930-5641
fax: 734-930-5932
address: PO Box 134002 Ann Arbor, MI 48119