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Chlorhexidine as a disinfectant in prosthodontic practice: An overview

Sushmi CB[1], Sujitha VB[1], Yogasri A[1], Yuvashree M[1], Gokul S[2]
[1] CRRI, Department of Prosthodontics, Karpaga Vinayaka Institute of Dental Science, Madhurantakam Chengalpattu, Tamilnadu, India
[2] Reader, Department of Prosthodontics and Crown and Bridge, Karpaga Vinayaka Institute of Dental Science, Madhurantakam Chengalpattu District, Tamilnadu, India

Abstract
Disinfectants are many active chemical compounds called biocides, which can fight microorganisms on noninvolving surfaces and human skin It is an antimicrobial agent that can applied on the surface of some objects in order to destroy the microorganisms residing on it. The types of disinfectants include alcohol, chlorine and chlorine compounds, formaldehyde, glutaraldehyde, hydrogen peroxide, iodophors, and phenolic.
Chlorhexidine is a disinfectant used to sterilize surgical instruments and for skin disinfection before surgery. Chlorhexidine is active against gram positive and gram negative organisms, facultative anerobes, aerobes and yeasts. It is an effective antifungal agent. Use of chlorhexidine based mouthwash reduce the plaque build up and improve mild gingivitis.

Keywords: Biofilm, chlorhexidine, impression disinfectant, denture disinfectant, acrylic

Introduction

CHX is one of the most commonly used drugs in dental treatment. Very effective It is effective against various types of microorganisms and has a broad spectrum biocidal effect. It is effective against both Gram-positive and Gram-negative bacteria. Also effective against yeast the same goes for some dermatophytes and lipophilic viruses. At low concentrations, CHX It has a bacteriostatic effect, but at high concentrations it has a bactericidal effect, causing bacteria. Cell death due to cell lysis [8]. In dentistry, it is used in the form of mouth gels, mouthwashes, and mouth rinses. As an ingredient in dental foams or toothpastes, and dental floss or prophylactics Medical products. The permissible concentration of active CHX is 0.1%. Daily use in special cases up to 3% [12]. The use of 0.2% CHX significantly reduces oral absorption Recommended as an easier and cheaper alternative to colonization. Traditional hygiene protocols for elderly edentulous. In many studies confirmed that CHX helps reduce can cause discoloration of teeth and fillings. The activity of CHX depends on the environmental pH and the presence of organic matter [11]

Cross-contamination of pathogens between dental offices and laboratories is well documented and poses a potential health risk to prosthodontic practices. Providing dental care involves dental health care professionals (DHCPs) such as dentists, dental assistants, dental hygienists, and laboratory technicians. DHCPs can be exposed to pathogenic microorganisms such as hepatitis B virus, hepatitis C virus, Mycobacterium tuberculosis, staphylococci, streptococci, and other viruses and bacteria that colonize the oral cavity and upper respiratory tract [1]. Dentures can transmit infections from the patient to the DHCP during various stages of examination and insertion. Additionally, these dentures are sometimes returned for repairs or adjustments, exposing them to the oral microbiome, including bacteria, fungi, and viruses. Therefore, DHCPs working with these prostheses may be at increased risk of infection if proper disinfection procedures are not followed [2, 3]. This can create a cycle of cross-contamination, potentially exposing other staff and patients to infection [4]. Therefore, it is important to implement strict infection control measures at every stage. According to Centers for Disease Control and Prevention (CDC) guidelines, dentures are considered semi-critical devices and must undergo high-level disinfection or sterilization [5]. Disinfectants must have bactericidal, fungicidal, and virucidal properties. These include various formulations and combinations such as 5.25% sodium hypochlorite, 2% glutaraldehyde, 3% hydrogen peroxide, phenolic compounds, and 2-4% chlorhexidine gluconate (CHX). The U.S. Food and Drug Administration (FDA) has issued recommendations for the use of FDA-approved disinfectants and highly effective disinfectants for the reprocessing of reusable medical and dental devices [6]. Several studies have evaluated the effectiveness of various commercially available denture disinfectants using microbial colony counts and scanning electron microscopy (SEM), using different durations, number of disinfection cycles, and techniques such as soaking and scrubbing. We are comparing the effectiveness of and spray disinfection [1, 4, 7]

Mechanism of Action and Antimicrobial Effectiveness

CHX has a bactericidal effect, causing disruption of cell membranes and leakage of intracellular tissue, including potassium (at low concentrations) or respiratory inhibition and loss of nucleic acids (at high concentrations [13]. CHX inhibits glycosyltransferases and a pair of phosphoenolpyruvate phosphotransferases, enzymes required for the function and maintenance of the bacterial glycolytic pathway [14].

In addition to yeast, CHX has a wide range of activity against Gram-positive and Gram-negative microorganisms. CHX varies depending on the type of microorganism. Gram-positive bacteria are more susceptible than Gram-negative bacteria. For example, Pseudomonas aeruginosa (a Gram-negative bacillus) [15]. This is probably due to the lack of an outer membrane and the presence of teichoic acids within the cell wall [13, 14]. Furthermore, CHX can exhibit bacteriostatic effects and prolong the release time by adsorption to the oral surface [16].

MOA begins with the rapid attraction of cationic CHX molecules to the negatively charged bacterial cell surface, which contains phosphate and sulfate groups [17, 18, 19].

The cationic nature of CHX allows it to bind to negatively charged sites within biofilms such as bacteria, extracellular polysaccharides, and glycoproteins [17, 20]. This allows it to specifically and strongly adsorb to phosphate-containing components that form the surface of bacterial cells [18, 21] Penetration of the bacterial cell wall occurs by passive diffusion, which attracts the cell's plasma membrane, damaging it and compromising its integrity [18]. This event allows CHX to penetrate into the cell membrane, increasing permeability [17, 18].

As a result, low molecular weight molecules and cytoplasmic components such as: B. Potassium ion. Leads to inhibition of the activity of several enzymes associated with the cytoplasmic membrane [17, 18, 20]. At this point, the antibacterial effect of CHX remains at the bacteriostatic stage, but it can be reversed when CHX is removed [17, 18, 21]. However, if CHX concentrations remain stable or increase over time, irreversible cell damage and bactericidal conditions occur [17, 21]. The disinfection stage involves coagulation and precipitation of the cytoplasm through the formation of complexes with phosphorylated compounds such as adenosine triphosphate and nucleic acids [17, 18, 21]. Because most oral surfaces (including mucous membranes, teeth, and salivary glycoproteins) are negatively charged, the cationic nature of the CHX molecule adheres well to these surfaces, impeding bacterial attachment, and persisting for up to 12 hours. We guarantee [17, 20]

CHX has bactericidal effects and causes disruption of cell membranes, leading to leakage of potassium-containing intracellular tissue (at low concentrations) and respiratory inhibition and loss of nucleic acids (at high concentrations) [26]. CHX inhibits glycosyltransferases and a pair of phosphoenolpyruvate phosphotransferases, enzymes required for the function and maintenance of the bacterial glycolytic pathway [27]. In addition to yeast, CHX has a wide range of activity against Gram-positive and Gram-negative microorganisms. CHX varies depending on the type of microorganism. Gram-positive bacteria are more susceptible than Gram-negative bacteria. For example, Pseudomonas aeruginosa (Gram-negative bacillus) [28] Furthermore, CHX can exhibit bacteriostatic effects and prolong the release time by adsorption to the oral surface [29].

Disinfection technique

The American Dental Association (ADA) recommends that instruments that penetrate or contact soft tissue or bone be sterilized or discarded after each use [22]. This is typically accomplished by autoclaving at various temperatures and pressure levels for an acceptable amount of time using specific items specified by the manufacturer [23]. However, existing impression materials cannot be heat sterilized. Therefore, it is usually treated with a suitable chemical disinfectant. This method is less effective than sterilization, which is classified as medium-level disinfection. Disinfectants must be effective in killing microorganisms and must not adversely affect the dimensional stability of the impression material or the reproduction of surface details. The ADA recommends dental disinfectants such as phenol iodophors, quaternary ammonium compounds, sodium hypochlorite, glutaraldehyde, and CHX gluconate [24, 25]. Surface disinfectants can remove most harmful microorganisms, but there is no way to test their effectiveness. For example, soaking in a 2% glutaraldehyde solution for approximately 10 hours removes bacterial spores and provides sterilization. However, this sterilization method cannot be routinely verified by spore testing and is not recommended for items that can be sterilized by heat [24].

Many disinfection techniques have been proposed in the literature, such as spray disinfection and immersion disinfection. Spray disinfection is suitable for materials that can cause negative dimensional changes, such as alginate impressions. It is also easy to use and relatively inexpensive, as only a small amount of disinfectant is dispensed. Immersion disinfection, on the other hand, is a good approach to increase exposure to disinfectants, especially chlorine dioxide. However, the latter is a somewhat more delicate technique compared to the spray method, as it requires the use of large amounts of disinfectant, especially in the case of non-dosed materials, and the need to completely immerse the object in water., more expensive [24]

Clinical Application

Dental Impressions: The use of dental impressions and the resulting cast impressions is an important means of obtaining and transferring information from the dental chair to the laboratory in prosthodontics and general dentistry practice. Many different types of impression materials with different physical and chemical properties are commonly used. Microorganisms can be transmitted through dental impressions and reproducible impressions [22, 30]. The ADA recommends rinsing dental impressions to remove saliva, blood, and debris. We recommend rinsing the cast under running water to remove any visible signs of contamination, and disinfecting the cast with an appropriate agent before casting or taking it to the laboratory. Gloves should also be worn when injecting the impression [31]. Work is received at a designated area, impressions are cleaned and disinfected, and it is recommended that personnel handling impressions wear protective clothing and disposable gloves [25]

A previous study investigated techniques used by dentists in the United States to disinfect tooth impressions. This assessment was created to assess how well dental laboratory employees communicate with dentists about impression disinfection. Her 23 percent of laboratory managers were unaware of the disinfection process used, and 47 percent were unaware of the time required. Nearly 50% reported receiving inadequate instruction on disinfection techniques and no established disinfection protocols to follow [32].

Disinfection of non-elastic impression materials: There is insufficient literature regarding the effectiveness of CHX disinfection regimens on non-elastic impression materials. Olsen *et al*. An investigation of the effect of immersion disinfection on the sharpness and dimensional stability of zinc oxide eugenol impression materials revealed that 1-hour immersion in any of seven different disinfectants did not result in clinically relevant changes [33]. Disinfection of reversible hydrocolloid impression materials: There is no literature describing the use of CHX to disinfect impressions made with reversible hydrocolloid impression materials.

Townsend *et al*. We investigated the effects of other disinfectants such as iodophor, glutaraldehyde, and phenol and found that a 10-minute soak or spray approach with these disinfectants did not affect the accuracy of reversible hydrocolloid materials [34]. Disinfection of irreversible hydrocolloids, polyvinylsiloxanes, and condensed impression materials: Irreversible hydrocolloid-alginate impression materials are widely used in dental practice because they are easy to use, affordable, and patient-friendly. Alginate materials usually come as a powder and must be mixed with tap water at room temperature. Under ideal conditions, alginate materials have proven to be the most accurate of the materials currently known, but they can also be adversely [35]

Compared to CHX, glutaraldehyde immersion resulted in statistically significant changes in linear dimension values. Analysis using scanning electron microscopy (SEM) revealed that the crystal structure of tooth impressions changes significantly upon immersion of the impressions. Bergman *et al*. investigated the effect of disinfectants containing 2% glutaraldehyde and 0.5% CHX on the dimensional stability and surface detail reproduction of four different alginate materials [36]. Soaking for 1 hour resulted in unacceptable dimensional changes in all four impression materials, leading to the conclusion that the alginate material should not be soaked for this period. Ivanish *et al*. These results were compared to those for dip addition of siloxane, polyether, and poly(vinylsiloxane) [37]. The molds obtained from the immersed polyether samples show significant linear dimensional changes and are not suitable for disinfection by immersion in CHX-gluconate. However, for the other two materials exposed to 24-hour immersion, the linear dimensional changes were within clinically acceptable limits. From a dimensional stability point of view, alginate appears to be less responsive to immersion than other elastic impression materials. Nevertheless, spray disinfection is less harmful than soaking [38].

In general, disinfectant rolls should ideally serve two purposes. It must be an effective antimicrobial agent and, at the same time, must not adversely affect the dimensional accuracy and surface properties of the impression material and the resulting plaster model [37, 39]. Several methods have been proposed for disinfecting alginate impression materials. In clinical practice, spray and dip methods are most commonly used. However, these traditional methods have many drawbacks, such as loss of surface detail and dimensional inaccuracy of the impression. Because of the challenges in disinfecting alginate impression materials, an alternative strategy using self-disinfecting alginate impression materials has been developed. According to the study, this technology demonstrated better dimensional stability than spray and dip techniques while saving disinfection time [40, 41].

Disinfection of interocclusal recording materials: Gounder and Vikas used spray and soak methods to test Jet Bites (additional silicone), Aluwax, and Ramitec for linear dimensional stability with 0.5% CHX, 1% sodium hypochlorite., and 2% glutaraldehyde (polyether) on 30- and 60-minute interocclusal recording materials using spray and dip techniques [43]. Disinfection of soft relining materials: Pavan *et al*. Determining the hardness of four long-term soft denture insoles after disinfection treatment with chemical solutions (2% glutaraldehyde, 5% sodium hypochlorite, 5% CHX) and microwave energy. I inspected it [48].

Disinfection of maxillofacial dentures: To prevent microbial contamination in the dental laboratory, it is important to disinfect dentures before the procedure [28]

Acrylic resin and silicone are the most commonly used materials for the manufacture of jaw and facial prostheses. Silicone is considered the material of choice due to its flexibility, comfort for the patient, and texture similar to human skin [45] All disinfectants resulted in statistically significant reductions in biofilm survival. Micrographs showed that 4% CHX affected the polymer surface. Hygiene of silicone polymer jaw and facial prostheses is a delicate process and improper handling can accelerate material deterioration [47]. The 4% CHX solution was not an effective disinfectant against C. albicans as the residual rate of microorganisms after 10 min of immersion was approximately 50%. According to this study, the surface was impregnated with 4% CHX, which resulted in surface changes and increased surface roughness. Regular contact with disinfectant solutions can affect the properties of silicone, causing changes in color, hardness, and tear strength [48]. The best disinfectant should meet most of the requirements of an ideal disinfectant without changing the structure of the prosthesis. The main advantage of CHX disinfectant is that it is non-corrosive and does not destroy plastic or rubber materials. However, it is toxic and must be handled with care [50]. In the dental field, the surface roughness of restorative and prosthetic materials greatly affects their quality, potentially reducing durability and increasing porosity. In the study conducted by da Silva *et al*., the authors were able to detect differences in surface roughness when the prosthesis was disinfected with six different disinfectant solutions. CHX disinfectant slightly reduced the surface roughness of the dentures, but no significant surface changes were observed [50].

For silicone maxillofacial prostheses, frequent exposure to disinfectant solutions can affect the properties and properties of the silicone, resulting in changes in color, hardness, and tear strength [48]. The contact time of the disinfectant with the prosthesis material should be controlled to avoid changing the texture of the silicone surface. This can also compromise the color stability and appearance of the prosthesis [49]. Immersion in 4% CHX for 10 min revealed changes in the polymer surface that may contribute to increased microbial adhesion [46]. There are several variables to consider when choosing a disinfectant. One of them is shelf life. This is defined as the maximum period of time that an unused product can be stored before its effectiveness is no longer guaranteed by the manufacturer. The second factor is the duration of use, or the maximum period of time that the disinfectant remains effective [52, 53]

Conclusion

Based on this scoping review of the literature, the following conclusions were drawn. Previous studies have investigated CHX at various concentrations ranging from 0.2% to 5%. We recommend disinfecting all casts by soaking them in CHX at a concentration of only 0.2% for at least 10 minutes. The ability to carry out this disinfection in the clinic is very important to prevent microbial contamination from dental laboratories, and the use of CHX as a disinfectant by spray or immersion techniques can help achieve good disinfection of dental impressions. It has been proven to be effective. Prosthesis. CHX has proven to be a very useful antimicrobial agent in the healthcare field. In dentistry, its versatility as a chemotherapeutic agent is unparalleled when mechanical prophylaxis is not possible. CHX mouthwash can achieve the recommended 18 to 20 mg per application at concentrations of 0.12% to 0.2%. CHX mouthwashes are recommended over gels and toothpastes because they are significantly better at inhibiting plaque and have no serious side effects.

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