

Disinfection Of Impression Material - A Review

¹Sree lakshmi S.B, ²Jayalakshmi Somasundram, ³R.V Geetha

¹Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai 77.

²Chief Scientist, White Lab- Material Research Centre, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, saveetha University, Saveetha university, Chennai 77 ³Associate professor, Department of Microbiology, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha university, Chennai 77

Email: ¹151801038.sdc@saveetha.com ²jayalakshmisomasundaram@saveetha.com
³geetha@saveetha.com

Abstract: *Dental impressions are categorized under semi-critical objects in dental practice and require high level disinfection or sterilization. Sterilization in an autoclave will compromise the dimensional accuracy of the impression hence it is not feasible. Until 1991, the recommended procedure for disinfection of impression was rinsing under running water with which only 40% of bacteria, viruses and fungi were removed and potential for transmission of microorganisms remained there. In recent times, a pre wash of the impression with running water is advocated first to cast off all particles, blood and saliva prior to active disinfection procedure. Disinfection of dental impression should be a routine procedure in the dental office and dental laboratory. However, most of the dental professionals in private clinics, hospitals, dental schools and prosthetic laboratories are not following the required protocols for impression disinfection. Keeping in view the above findings, it is of utmost importance to raise the level of awareness in dental professionals involved in any process of handling, transportation, processing and storage of the dental impressions.*

With this background, the aim of this review is to generate an update on the various techniques of impression disinfection along with their mechanism of action, dimensional stability, cause of infection on impression material and effects of disinfectant on impression materials.

Keywords: *cross infection; dimensional stability; disinfection; impression materials*

1. INTRODUCTION:

One of the primary functions of dental surgeons as health professionals is to prevent diseases in their field or when diseases are set in to treat it. The actual worrying about the cross infection strongly increased after the rapid evolution of AIDS and hepatitis B, leading the American dental Association(ADA) to publish guidelines about the control of infection in dental offices and laboratories(Badrian *et al.*, 2012) . Among these instructions, such as the use of gloves, caps, masks, eyeglasses, protective over wear garment and sterilisation of all

dental materials, there is also concern about impression, which along with trays, are important ways of transmission between patient and dental laboratories. The impression materials differ widely in terms of absorption and retention of viruses (Bergman, Bergman and Olsson, 1985) . Even the occupational safety health agency (OSHA) have made some protocols to prevent infection in the laboratories (Rueggeberg *et al.*, 1992). Specific disinfectant procedures should be followed for each material and the stone cast are potential sources of cross infection in dentistry (Pratten, 1987) . Soganci et al emphasised the importance of cross infection in his study (Soganci *et al.*, 2018). The control of cross infection is a process that consist of various stages such as identification of high-risk population, use of technical barriers both professional and the assistance, technique of disinfectant and sterilisation of instruments, surfaces, materials using 2% glutaraldehyde, NAOCL, ammonium compounds, autoclaving etc (Ramer, Gerhardt and McNally, 1993) . The elastic recovery of impression material without any deformation is important on removal of material from the mouth (Silva and Salvador, 2004). Moreover the material should be dimensionally stable during disinfectant and also during storage, because it takes some time to pour the cast . Therefore it is essential that the dimensional changes in the impression material are limited to permitted changes of 0 to 0.15% (Thouati *et al.*, 1996). The varying combinations of both disinfectant and impression material produce different results in the dimensional changes of the impression materials (Pasini, Boscarioli and Pinto, 2010). Disinfection and sterilization methods are used to free microorganisms on the medical and surgical instruments. The primary duty of the healthcare professionals is to provide the appropriate methods of cleaning, disinfection and sterilization for various surfaces and instruments and materials to avoid the spread of pathogens . The cleaning is the elimination of all foreign material (e.g. blood, saliva, debris) from materials and decontamination is the complete removal of pathogenic microorganisms from objects. Disinfection is the destruction of all pathogenic organisms on inanimate objects. While sterilization is the complete elimination of all microorganisms including spores. The nature of the disinfection varies according to the product used . On this basis disinfectant can be divided into three categories namely low level ,intermediate and high level disinfection. High level disinfectants such as glutaraldehyde and hydrogen peroxide destroy the vegetative bacteria, mycobacteria, fungi and enveloped (lipid) and non enveloped (non lipid) viruses, but not necessarily bacterial spores (Chakraborty *et al.*, 2014). Intermediate level disinfectants such as alcohols, iodine and iodophors involve destruction of microorganisms like tubercle bacilli but are not able to kill spore. Low level disinfectants such as phenolic and quaternary ammonium compounds used to clean the environmental surfaces.

The clinical items can be classified into three categories namely critical ,semi critical and non critical according to CDC . Dental impressions come under semi-critical objects which tend to come in contact with the mucosal membrane but not penetrate bone. They are usually handled with gloves because they are usually coated with blood and saliva which require high level disinfection or sterilization. The Sterilization in an autoclave will compromise the dimensional accuracy of the impression material so it's not recommended (Premkumar *et al.*, 2014). The only means of disinfection is washing the impression materials directly under running water which only removes 40% of microorganism and all the potential pathogens

causing the diseases are present . Nowadays the particles contaminated with blood and saliva are washed with running water before performing the actual disinfection (Shree *et al.*, 2019). The complete disinfection of the dental impression and the materials should be a regular process followed in the dental hospitals and laboratories. The majority of private clinics, hospitals, dental schools and even prosthetic laboratories are not following the required guidelines for disinfecting the impression which leads to cross infection . (G. Jayaraj *et al.*, 2015). It is significantly important to create awareness to dental professionals about the handling, transportation, processing and storage of dental impressions (Sridharan *et al.*, 2019). Different techniques of impression disinfection and other methods of cross-infection control must be a part of the undergraduate curriculum of dental universities and dental technician schools (Kumar and Gheena, 2015). With this background the aim of the review is to concentrate on the various techniques of impression disinfection along with their mechanism of action , dimensional stability , cause of infection on impression material and effects of disinfectant on impression materials.

2. MATERIALS AND METHOD:

The articles, journals and documents related to the topic were searched and collected from Search engines like PUBMED, google scholar, semantic scholar, MESH CORE , elsevier and medline. The period of collection of articles from 1980 till date were considered. The inclusion criteria taken into consideration were articles related to the impression material and its effects by disinfectant. The exclusion criteria includes that the article is not related to the topic and article published before 1980.

Impression material and disinfectant:

A dental impression material is defined as the negative record of the tissues of the mouth. It is used to produce the form of the teeth and the surrounding tissues (Johnson *et al.*, 1998). The ideal characteristics of dental materials are pleasant odour, taste and esthetic colour, doesn't contain any toxic or irritating ingredients and economical, exhibits dimensional stability, adequate tear strength possess elastic property, shelflife (Martin, Martin and Jedyakiewicz, 2007). The impression materials are classified into rigid and elastic based on the properties . So the commonly used impression material is alginate which is an irreversible elastic hydrocolloid material. It is used for making impressions for preparation models and cast for primary impression. The most dimensional stable impression material is additional silicon because it doesn't release any byproducts (Birnbaum, 1995) . So talking about impressions they are highly contaminated with patient saliva or blood. Such fluids can have viral and bacterial pathogens. To avoid cross infection, impression material should be rinsed thoroughly under the running tap water before disinfection to remove as much by a burden as possible (Peutzfeldt and Asmussen, 1990). For adequate inactivation of microbial contaminants, the contact time between impression and disinfectant should be at least equal to the time for tuberculoid activity as recommended by manufacture of germicide (Rai, Easwaran and Dhivya, 2017). Rinsing after impression disinfection is also essential to remove residual Stone, soap or disinfectant from impressions surface.

Cause of infection on impression materials:

Dental impression after taking out the patient mouth, the material contained saliva and blood, which is the source of infection. Even the presence of caries have microorganisms in them which is seen in the impression material after removal (Sherlin *et al.*, 2015). Most of the impression materials used have a feature of retaining microorganism on their surfaces (Leung and Schonfeld, 1983). Impression procedure frequently causes bleeding from oral tissues. So when there is a rupture of skin happens, the blood which has a potential to culture microorganism and also acts a microbial transportation which leads to the entry of pathogenic microorganism and spreads to the intimate places. Materials like irreversible hydrocolloids are often positioned against mucous membranes, when used and could potentially result in inoculation of the microorganism on the impression material from the patient (Savabi *et al.*, 2018). So to avoid this kind of contamination proper disinfection techniques and methods should be followed in dental laboratories and hospitals. Various non elastic and elastic impression materials are used for making impressions (Swathy, Gheena and Varsha, 2015). Before disinfecting the impression material there are key elements to be understood such as presence or absence of surfactants and their tolerance to immersion on water or other chemical fluids based on the hydrophilic nature of the materials (Milward and Waters, 2001). For example

, polyether impression material is hydrophilic in nature, which absorbs water and other chemical liquids during disinfection causing dimensional changes and the loss of surfactants affects the wettability of the impression. Despite alginates are susceptible to both wet and dry environments

The different methods used for disinfecting the impressions are more technique sensitive and time consuming. Some disinfectant solutions may cause notable changes in impression material, particularly when exposed for a long period of time. Disinfection depending on the solutions used, produces irritating vapours which are major drawbacks (Anusavice, 2003). Considering all these drawbacks, UV rays can be used as an alternative method for disinfection. UV chambers are now readily available in all dental clinics and are also used for storing the sterilized instruments. Ultraviolet rays have long been recognized as an effective method for killing microbes without requiring chemicals or heat (Gheena and Ezhilarasan, 2019). The working principle of these UV rays are, when microorganisms exposed to a particular wavelength (ie 200-280 nm), the reproduction capacity of microorganisms are inhibited and inactivation occurs at a faster rate, which leads to the safety use of the materials without any threats.

3. METHODS OF DISINFECTION:

Destruction or inactivation of pathogenic microorganisms results in stopping their reproduction and growth. Chlorine is a greenish-yellow gas and by providing a high pressure, the gas turns into liquid which is toxic. Chlorine gas is widely used as a water disinfectant. Introducing chlorine to water plays a very effective role for removing almost all pathogenic microorganisms (Gupta and Ramani, 2016). It is effective for both primary and a secondary disinfection of impression materials. The gas cannot be used for household

disinfection because of its toxicity and its danger . It is lethal at concentrations as low as 0.1% air by volume. Sodium hypochlorite, a commonly used disinfectant , used as a bleaching agent for papers and textiles. The solution generally contains 10–15% of the available chlorine, but rapidly loses its force in the storing process. Regular controlled environment is needed as the solution is affected greatly by the pH, light, heat, and heavy metals (Dong and Liang, 2009). Chlorination ,Ca(OCl)₂ (calcium hypochlorite) is an essential solid that can be used in replacement of NaOCl (liquid). When compared it has a similar property of NaOCl as a disinfectant but it is much safer to handle. Almost 70% of chlorine is available in commercial grades of Ca(OCl)₂. It has applications in both wastewater and drinking water.

When free chlorine reacts with ammonia , chloramines are formed . Chloramines have a significant role and they are very stable. When comparing chlorine and chloramines , chlorine releases certain byproducts

. When three molecules of oxygen are combined there lead to the formation of ozone which is an allotropic structure . It quickly decomposes to generate highly reactive free radicals(Craig, 2006) . The ozone's oxidation potential (–2.7 V) (that is the ability of chemical species to gain or lose electron) is more than that of the chlorine (–1.36 V) and hypochlorite ion (–1.49 V) and these substances are extensively used in wastewater treatment as an oxidants. Ozone is surpassed only by the hydroxyl radical (•OH) and fluoride in its oxidation capacity.UV treatment can be used for treating waste water, drinking water, and aquaculture(Johansen and Stackhouse, 1987). The UV light causes disinfection by changing the biological components of microorganisms specifically breaking the chemical bonds in DNA, RNA, and proteins(Sridharan, Ramani and Patankar, 2017). The acceleration of a photoreaction in the presence of a catalyst is referred to as photocatalysis. The adsorbed substrates such as H₂O are used to absorb light in the catalyst photolysis process . In photogenerated catalysis, electron–hole pairs are created by the photocatalytic activity (PCA) generating free radicals (e.g., hydroxyl radicals: •OH) that have the ability to undergo secondary reactions. Its practical application was made possible by the discovery of the electrolysis of water by using titanium dioxide (Gifrina Jayaraj *et al.*, 2015).

Mechanism of action of disinfectant:

Disinfectant or chemical biocides to use a more general term differ from antibiotic agents in their relative lack of selecting toxicity and often implied lack of target specificity. Disinfectant acts on microorganisms in two different ways, growth inhibition (static) or lethal action (cidal)(Poullis, 2016). The disinfectant has its action on bacterial wall, cytoplasmic membrane, energy metabolism, cytoplasm and nucleus, bacterial spores . Acidic and alkaline compounds are linked to the H⁺ and OH⁻ concentration. H⁺ ions destroy the amino acid, precipitating proteins ,whereas OH⁻ ions saponify the lipids in the enveloping membrane (Varghese, 2008). Chlorine derivative acts by oxidising peptide linkage and the natural proteins, since chlorine is electronegative. The quaternary ammonium compound irreversibly binds to phospholipids and proteins of the membrane, thereby impairing permeability (Davies and Porra, 1994). Phenolic compounds

act specifically on cell membranes and inactivate intra cytoplasmic enzymes and form unstable complexes. Aldehyde compounds act by protein denaturation and on nucleic acid by alkylation (Nespraydko *et al.*, 2015). Peracetic acid and hydrogen peroxide denatured proteins and lipids of microorganisms, leading to this organisation of the membrane.

Whereas several alcohols such as ethyl alcohol (ethanol, alcohol), isopropyl alcohol (isopropanol, propan-2-ol) and n-propanol are effective antimicrobials and are commonly used. Alcohols exhibit rapid broad-spectrum antimicrobial activity against vegetative bacteria (including mycobacteria), viruses, and fungi but are not sporicidal (Jangid *et al.*, 2015). Alcohol works on the principle of inhibiting sporulation and spore germination, but this effect is reversible. They have wide applications as hard-surface disinfection, skin antiseptics and in lower concentrations used as preservatives and since there is a lack of sporicidal activity, alcohols are not suggested for sterilization. Many alcohol products have other biocides mostly chlorhexidine in combination, which remain on the skin, leading to evaporation of the alcohol, or excipients (including emollients). These biocides decrease the evaporation time of the alcohol and can significantly increase product efficacy (Thangaraj *et al.*, 2016). In general, isopropyl alcohol is considered slightly more efficacious against bacteria and ethyl alcohol is more potent against viruses.

Effect of disinfectant on non-elastic and elastic impression materials:

Publications examining the interaction between impression material and disinfectant began to appear in dental literature in about 1980 and that quite frequently found for one or two decades. The research was readily oriented towards two main areas which comprises the main requirement for a disinfectant, the efficiency of disinfecting solution in eliminating the pathogens and influence of disinfection treatment on the properties of impression material (Look *et al.*, 1990). The critical qualities affected by disinfectant are surface properties such as dental reproduction, surface roughness and dimensional alteration, (Melilli *et al.*, 2008). Hydrocolloids should be disinfected for a limited time period. Immersions are more secure than spraying and self disinfecting materials are efficacious but better accompanied by immersion. Polyether can be effectively disinfected by spraying. Long-term immersion of hydrophilic silicon may enhance their absorption potential (Nandini, Vinitha and Smitha, 2013). Hydrophobic elastomeric materials can be safely immersed in disinfectant and left for a long period. The possibility of unpredictable interaction between various constituencies dictates that each newly marketed impression material must be tested for compatibility with common disinfectant (Viveka *et al.*, 2016). Investigation exploring the dimensional changes of new material should be and some of them do, include a chemical disinfectant method in experimental protocol, contributing to the establishment of disinfection process as a standard clinical routine and promoting professional awareness of its necessity (Wood, 1992).

Limitations Of Disinfection

Some factors that limit the accuracy of impression material are different storage time, effect of disinfectant, proportion of inorganic filler on the impression material. The disinfectant has toxicity, handling problems, dimensional changes and alters the surface texture. Impression

materials have a limitation in flowing, hydrophilicity, short working time, poor tear strength and high cost.

Future scope:

1. Further more focus on dimensional alteration after long term (overnight) disinfection, which is more conveniently incorporated in the clinical practice.
2. explores the effects of disinfection procedure on the dimensions of the tray, especially in relation with the long term contact.
3. Specify the role of gypsum products used to make the cast on the final dimensional differentiation which actually is the combined effect of impression material setting, disinfectant and gypsum product setting.

4. CONCLUSION :

The disinfectant acts by destroying the bacteria present on the surface, suppresses their growth and the ability to reproduce. The application of disinfectant on impression materials prevents the infection, contamination of laboratories and prevents cross infection to the dentist and other employees. Disinfectant efficacy depends on the impression material used and microorganism present on the surface. The disinfectant solution applied on impression material has the tendency to affect both the microorganism and the accuracy, surface structure and stability.

Authors contributions :

All authors have contributed equally to the study.

CONFLICT OF INTEREST :

The authors declare that there is no conflict of interest.

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