EFFECTIVENESS OF SPRAY DISINFECTANTS ON THREE DENTAL IMPRESSION MATERIALS

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ABSTRACT

EFFECTIVENESS OF SPRAY DISINFECTANTS ON THREE DENTAL IMPRESSION MATERIALS

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Background: The disinfection of dental impressions is fundamental to prevent cross-infection from the dental surgery to the laboratory. Spray rather than immersion disinfectants have recently been introduced to dental practice. This study aimed to compare the effectiveness of two spray disinfectants used at Hamdan Bin Mohammed College of Dental Medicine (HBMCDM) in Dubai, United Arab Emirates.

Materials and methods: Two disinfectants were compared, a new non-aldehyde alcohol based disinfectant, Bossklein (Silsden, W Yorks, BD20 0EF, UK) and an aldehyde based disinfectant, MD520 (Dürr Dental, 74321 Bietigheim-Bissingen, Germany). Impressions taken on the prosthodontic and orthodontic clinics were swabbed immediately after rinsing under running tap water (pre-disinfection) and after spraying (post-disinfection). Maxillary or mandibular impressions taken in alginate (irreversible hydrocolloid), polyether and polyvinyl siloxane (PVS) were swabbed from the same gingival areas before and after spraying. Manufacturer's instructions were followed regarding the spray protocol for Bossklein which was to soak thoroughly and leave to dry naturally. To standardize the method of delivery, hand spraying only, MD520 was also used from a spray bottle as the gold standard but subsequently the Hygojet box system was not used as per manufacturer's direction. Swabs were transported to the microbiology laboratory, MedLab, in Amies medium. All swabs were plated onto blood agar within 2 hours. Plates were incubated for 3 days at 37^{o}C then at room temperature for 3 days. After incubation, the number of contaminated impressions before and after disinfection

for each impression material was compared using the chi square test with the level of significance set at $p<0.05$.

Results: A total of 87 impressions were assessed (alginate=41; PVS=31; polyether=15). The counts were categorized into 2 groups: no growth or growth present. Post-disinfection contamination was present on 6 alginate and 6 PVS impressions but only 1 polyether impression ($x^2=1.27$, NSS). Analysis of post-disinfection growth according to impression and disinfectant found significantly more contaminated PVS impressions sprayed with Bossklein than with MD520 ($x^2= 5.37$, $p<0.05$). Disinfection with MD520 resulted in only 2 contaminated impressions, both in alginate.

Conclusions: Spray disinfection of dental impressions may not be as effective as immersion methods. Effective spray disinfection relies on correct operator technique such as thoroughness of soaking. A low number of trigger squeezes of spray bottles may be related to cost saving which is an issue immersion disinfectants do not have. Dental staff must be trained appropriately and understand that disinfection protocols differ.

DEDICATION

I dedicate this thesis to God Almighty my creator, the source of my strength throughout my life.

Also to my beloved parents, husband, sisters and brothers who encouraged and supported me all the way with their continuous love and prayers.

Many thanks and God bless you all.

DECLARATION

I, **Ayesha Abdulkarim Alshikh**, declare that this dissertation is my own original work, and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Name:

Signature:

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ABBREVIATION LIST

ADA	American Dental Association
CDC	Centers for Disease Control and Prevention
EPA	Environmental Protection Agency
NaOCl	Sodium Hypochlorite
IH	Irreversible Hydrocolloid
PVS	Polyvinylsiloxane
PE	Polyether
NSS	Not Statistically Significant

1. INTRODUCTION

Infection control in general medicine and surgery has been an important concept over the last two centuries. It became applicable in dentistry at a later stage when the dental profession believed that blood and saliva could be vectors of viral and bacterial infection.

Dental healthcare professionals have been able to meet numerous infection control challenges, ranging from the threats of blood-borne infections like hepatitis B and HIV to the re-emergence of tuberculosis. A wide variety of effective options are available in the marketplace to address and accomplish infection control goals.

The dental profession must assume that every patient treated is at risk of cross infection and to adopt appropriate control measures.(1) The most vulnerable to microbial cross-contamination from dental impressions are technicians. Thus dental laboratories should be isolated from possible pathogen transmission and prevent cross contamination from patients to technicians. Educating dental technicians of the basic understanding of infection transmission and potential risk from blood borne pathogens is essential.

The American Dental Association (ADA) advocated the use of infection control procedures in dental practice and provided dentists with resources to help them understand and implement them. The ADA urges all practicing dentists, dental auxiliaries and dental laboratories to employ appropriate infection control procedures as described in the 2003 CDC Guidelines.(2) and 2016 CDC Summary.(3) and to keep up to date as scientific information leads to improvements in infection control, risk assessment, and disease management in oral health care.

Dental impressions are considered among potentially infectious items as they are contaminated with patient's saliva and blood. Pathogens, if present in high enough number, can survive several days on impressions and then can be transferred onto set gypsum material.

Impression materials cannot tolerate heat sterilization therefore they must be disinfected chemically. Thus, the manufacturer's direction for disinfection must be followed.

Sterilization is a process intended to kill all microorganisms and is the highest level of microbial decontamination that can be achieved. Disinfection is a less lethal process than sterilization and is intended to kill disease-producing microorganisms but not bacterial endospores.(4)

Several types of impression materials have been used in making impressions. According to Philips science of dental materials.(5) they are classified into chemically reacting mode of setting which is "irreversible" and thermally changed materials which are "reversible ". Both having elastic and rigid consistency.

Impression plaster and zinc oxide eugenol are considered chemically setting materials, while compounds and waxes are thermally reacting but both are rigid. On the other hand; alginate, polysulfide, polyether and silicone are listed under elastic chemically reacting materials, while agar hydrocolloids are falling under elastic thermally reacting ones.

Disinfectants are classified into three levels (high, intermediate and low), based on their efficiency against vegetative bacteria, tubercle bacilli, fungal spores, lipid and non-lipid containing viruses and bacterial endospores.

Examples of each type are: ethylene oxide gas and immersion glutaraldehyde solutions for the high level. Chlorine compounds, formaldehyde, iodophors, alcohol and phenolic disinfectants are intermediate level. Simple quaternary compounds, simple phenolics and detergents are considered low level and have no use in dentistry.

Both immersion and spraying have been recommended for disinfection of impressions. The advantage of spraying is that it uses less solution, and often the same disinfectant can be used for general disinfection of operatory surfaces.

Of the various methods of disinfectant agent application, immersion is considered to be the most reliable.(6).(7).(8) because all exposed surfaces of the impression trays and materials are covered by the disinfectant.(9).(10).(11).(12) Such a technique, in comparison to spraying, minimizes the risks of incomplete coverage and the hazard of disinfectant inhalation by the user.(13) On the other hand, spraying is considered by some as a suitable disinfection method.(14) that also decreases the chances of impression distortion[14] that may occur following prolonged immersion. Considerations in selecting a disinfectant and technique include the type of impression material and personal preference.

Concerning the duration of exposure time of the impression material to disinfectants, manufacturer recommendations must be followed to achieve the tuberculocidal disinfection. The ADA recommendation (1991), suggests exposure to the disinfectant for no more than 30 minutes but for hydrophilic materials; a minimum time of disinfection (no more than 10 minutes) is required.

1.1 LITERATURE REVIEW

1.1.1 Classification of impression materials.(15)

There are several types and different classifications of impression materials but the major are as the following:

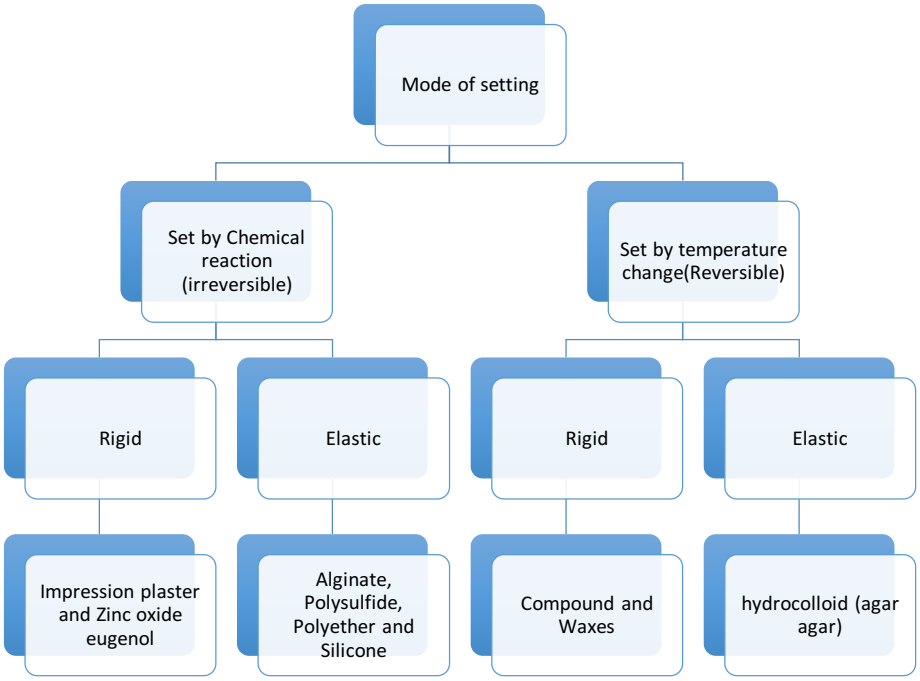

Fig 1: Classification of impression materials

1.1.2 Mode of action of chemical agents

Various methods of action of the chemical agents are available. The most common modes are protein coagulation, disruption of the cell membrane**,** removal of the free sulphydryl groups and substrate competition.

Disinfectant is defined as a chemical agent used on inanimate objects (i.e., nonliving) (e.g., floors, walls, sinks) to destroy virtually all recognized pathogenic microorganisms, but not necessarily all microbial forms (e.g., bacterial endospores). The EPA groups disinfectants on whether the product label claims “limited,” “general” or “hospital” disinfectant.(16)

Disinfection is the destruction of pathogenic and other kinds of microorganisms by physical or chemical means. Disinfection is less lethal than sterilization, because it destroys most recognized pathogenic microorganisms, but not necessarily all microbial forms, such as bacterial spores. Disinfection does not ensure the margin of safety associated with sterilization processes.(16)

1.1.3 Classification of disinfectant agents

- **Organic compounds:**

Aldehydes: Such as glutaraldehyde / Cidex which is a high level disinfectant. Especially active against tubercle bacilli, fungi and viruses. Less toxic than formaldehyde.

Phenols: Acts by cell membrane damage thus releasing cell contents and causing lysis**.** found in some mouthwashes and in disinfectant soap and hand washes. Eg. Cresol (LYSOL), chlorhexidine (SAVLON), chloroxylenol (DETTOL) and hexachlorophen. Low efficiency disinfectant.

- **Inorganic compounds:**

Chlorine: A concentration of < 1 ppm of available chlorine is sufficient to kill bacteria and viruses. Spores and mycobacteria require higher concentrations. Eg; sodium hypochlorite.

Iodophors & Iodine: Active against bacteria, spores & some viruses & fungi. (7.5% Povidone + iodine = Betadine).

Disinfection of impression materials is essential. It has been shown that none of the dental impression materials exhibited a complete bacteriocidic or fungicidic effect.(17)

1.1.4 Methods of disinfecting impressions

Immersion disinfection of alginate impressions for prolonged periods will cause distortion due to imbibition, but 0.5% sodium hypochlorite for 10 minute immersion is recommended by the ADA. (15)

Agar- Reversible Hydrocolloid was found to be stable when immersed in 1:10 dilution sodium hypochlorite or 1:213 iodophor for a recommended immersion time of 10 minutes.(15)

Zinc Oxide Eugenol impressions in general are compatible with a number of disinfectant solutions. However hypochlorite solutions found to be destructive.(18) Current ADA recommendations suggest immersion in a 1:213 iodophor or 2 % glutaraldehyde solution for ZOE disinfection. While for **impression compound** material it is advised to use a 1:10 sodium hypochlorite solution or an iodophor solution as an immersion technique. (15)

1.1.5 Antimicrobial activity of different types of spray disinfectants

Dental impressions are considered potentially infectious as they are contaminated with patient's saliva and blood. Since many pathogens, if present in high enough number, can survive up to several days and then be transferred and remain viable on set gypsum material. An in vitro study comparing the effectiveness of various spray disinfectants with different concentrations and contact time on irreversible hydrocolloid impression materials (alginate) concluded that not all the ADA-approved concentrations of surface disinfectants work equally well on an irreversible hydrocolloid (alginate) impression material. Moreover, diluted sodium hypochlorite (0.5%) for 10 min was very effective against S. aureus, S. viridans (5 log10 reduction), and B. Subtilis (3log10 reduction, 99.9%) while in full strength (5.25%) sodium hypochlorite was the most effective disinfectant overall and required the shortest contact time (1 min).(19)

Hamid et al.(20) conducted a study to investigate the effect of three different types of disinfectant agents on alginate impression material after 5 and 10 minutes. All samples of alginate impression material were disinfected with sodium hypochlorite 0.525%, Deconex (alcohol based disinfectant), and Epimax (broad spectrum hydrogen peroxide based products) using a spray technique. According to their findings the three kinds of disinfectant agents effectively disinfected alginate. This disinfection capacity can be increased as time elapses except for Pseudomonas aeruginosa which was eradicated effectively in both 5 minutes and 10 minutes. Among different types of disinfectant agents, Epimax showed promising results as it completely eradicated all kinds of microorganisms within 10 minutes.

Similar study to the one by Hamid et al.(21) but testing condensation cured silicone found that 0.525% NaOCl, Deconex and Epimax could effectively disinfect condensation cured silicone impression contaminated by the test microorganisms (Candida albicans, Staphylococcus aureus, and Pseudomonas aeruginosa.). Nevertheless, Deconex demonstrated promising results in decontamination of tested microorganism and it is recommended for disinfecting of condensation cured silicone impression materials by the spraying method. The anti-microbial activity of chemical disinfectants on alginate and silicone impression materials, concluded that alginate harbors three times more microorganisms than silicone impression material. Chemical disinfection by glutaraldehyde-based disinfectant was effective in eliminating all microbial forms for both alginate and silicone without modifying the dimensional stability. Alcohol-based disinfectants, however, reduced alginate shrinkage for up to 90 minutes after setting.(22)

In an in-vitro experimental study evaluating the effect of spraying Deconex on three different impression materials it was found that Deconex has the highest efficacy when it is used on silicone and it eradicated all microorganisms in both 5 and 10 minutes.(23)

Himanshu and colleagues evaluated the efficacy of 0.5 % Sodium hypochlorite and 2% Glutaraldehyde spray disinfectants on impression compound and irreversible hydrocolloid impressions. They concluded that 2% Glutaraldehyde and 0.5% Sodium hypochlorite were statistically equally effective both against gram positive and gram negative organisms. Sodium

hypochlorite 0.5% was found to be marginally more effective than 2% glutaraldehyde on irreversible hydrocolloid.(24)

Others evaluated and compared different types of disinfectants on hydrophilic polyvinylsiloxane (PVS) and polyether, and found that all tested products were effective in ten minutes either as spray or immersion technique.(25)

1.1.6 Antimicrobial activity of different types of immersion disinfectants

There are several studies in the literature that evaluated the efficacy of different concentrations of sodium hypochlorite used as an immersion disinfectant. Sodium hypochlorite has been shown to be an effective disinfectant for impressions; however, it has not been fully evaluated for optimum immersion time and concentration. Irreversible hydrocolloid impressions contaminated with different bacteria (Staphylococcus aureus, Salmonella choteraesuis, Pseudomonas aeruginosa, Mycobacterium bovis, and Bacillus subtilis) and immersed in varying concentrations of sodium hypochlorite for 1, 5, or 10 minutes. It was found that immersion disinfection of irreversible hydrocolloid impressions with full-strength sodium hypochlorite (5.25%) for 5 minutes was highly effective against Bacillus subtilis spores. More dilute solutions (0.525% or 0.0525%) were effective against Staphylococcus aureus, Salmonella choleraesuis, and Pseudomonas aeruginosa in 1 to 5 minutes. Furthermore, a 10-minute exposure to full-strength sodium hypochlorite was ineffective against Mycobacterium bovis.(26) A pilot study conducted to determine whether shorter immersion times of various concentrations of sodium hypochlorite would be effective to disinfect irreversible hydrocolloid impressions, concluded that disinfection of irreversible hydrocolloid impressions in a 0.6% solution of sodium hypochlorite for two minutes was sufficient to prevent bacterial growth and achieve disinfection of irreversible hydrocolloid impressions. This was as effective as the ADA's protocol of 0.5% sodium hypochlorite over ten minutes for the tested bacteria. Moreover, reducing the immersion time can also minimize changes in physical properties like dimensional stability and surface integrity.(27)

Aljabrah et al.(28) conducted a study to determine the effectiveness of four different disinfectant solutions on three commonly used impression materials (alginate, polyether, and polyvinyl siloxane), The disinfectants used in this study were Dimenol, Perform-ID, MD 520, and Haz-tabs. The results were that impressions sprayed with Dimenol for a 15-minute contact time and those immersed in 2% solution of Perform-ID for 10 minutes were found to be completely free of microorganisms but alginate specimens retained an average of 49 to 74 times more microorganisms than polyether and PVS, respectively. However, the differences between the 2 elastomeric impression materials were insignificant. Polyether specimens retained only 1.5 times more microorganisms than PVS specimens.

Polyether (Impregum) and an addition polymerized silicone (Elite) elastomeric impression materials contaminated with (Staphylococcus aureus, Pseudomonas aeruginosa and Candida albicans) were tested for resistance to disinfection by using MD 520 containing 0.5% glutaraldehyde and Sterigum Powder without glutaraldehyde disinfectant solutions. The authors found that disinfectant solutions did not appear to be equally effective on adhesive microbes, MD 520 was shown to be effective in reducing the microbial contamination on both impression materials. Sterigum was generally less effective but its performance was worse on the Elite elastomer.(29)

The efficacy of immersion disinfectants was tested on a range of microorganisms such as streptococci, staphylococci, Candida, methicillin-resistant Staphylococcus aureus, and Pseudomonas aeruginosa. All disinfection procedures demonstrated reduced colony growth versus the non-disinfected control samples. The least colony growth followed disinfection with the Hygojet/MD520 system and 0.25% benzal-konium chloride, followed by 2% glutaraldehyde, 1% sodium hypochlorite, and 1 ppm ozonated water. From the standpoint of microbiologic effectiveness and dimensional accuracy, the Hygojet/MD520 system can be recommended for clinical and laboratory use. Alternatively, the use of surfactants such as 0.25% benzalkonium chloride together with high or intermediate level disinfectants, such as

2% glutaraldehyde or 1% sodium hypochlorite, increases efficacy by possibly removing remaining proteins from the impression surfaces.(30) In agreement with the previous study; it was found that both disinfectant solutions (1% sodium hypochlorite and 2% glutaraldehyde) were effective in reducing microbial counts from alginate impression surfaces, with 2% glutaraldehyde having greater effect than 1% sodium hypochlorite.(31)

1.1.7 Disinfecting impressions using steam and ultra-violet chambers

Disinfectant solutions that contain chlorine are widely used in research on disinfection of impressions because they act rapidly against microbes, combat a wide range of bacteria, viruses and spores, and are also economical and effective. The undesirable effects of the immersion technique on gypsum casts; using the steam method was assessed through multiple studies. Mauro et al.(32) conducted a study to evaluate the antimicrobial effectiveness of 2.5% and 5.25% sodium hypochlorite steam to disinfect irreversible hydrocolloid impressions in Humidifier and Nebulizer Boxes and found that the mean number of colonies in control groups was significantly higher than in the experimental groups ($P<0.0001$). There was a significant difference between using the Nebulizer Box and the Humidifier Box when 2.5% sodium hypochlorite was used. At a concentration of 5.25% there was no statistical difference between the mean numbers of colonies for the two methods ($P>0.01$). So the study concluded that sodium hypochlorite at 5.25% can be used for disinfection in the Humidifier Box and Nebulizer Box methods. However, at a 2.5% concentration it is only effective in the Nebulizer box method.

Ultra-violet rays have been recognized as an effective method for killing microbes as exposure to 200-280 nm wavelengths destroys their reproductive capacity and inactivates them at a faster rate than disinfectants. While some disinfectant solutions may cause significant changes in impressions particularly with over exposure; the use of ultra-violet chambers “which are available in dental clinics” is an alternative disinfection technique. The efficacy of different disinfectants (immersion in 2% glutaraldehyde, 5.25% sodium hypochlorite) and ultra-violet

chamber against microbial contamination, all the three disinfection systems were found to be effective in reducing the microbial load with the ultraviolet chamber being the most effective.(33)

The use of a clinical ultra-violet chamber to disinfect various impression materials at different time intervals was compared with 2% glutaraldehyde as a standard immersion technique. The impression materials were divided into six groups: first was a control (un-disinfected) group, second was the 2% glutaraldehyde immersed group and the other four were exposed to ultra-violet rays at 3, 6, 10 & 15 minutes. Alginate, addition silicone and polyether Impression materials were tested. The authors concluded that an equal amount of disinfection was achieved at 10 minutes of glutaraldehyde immersion and ultra-violet exposure. Moreover; a complete disinfection was attained on exposure for a period of 3 minutes to ultra-violet radiation in case of Polyether Impression Material. Thus a dental ultra-violet Chamber used for storage of sterilized dental instruments may also be used to disinfect dental impressions successfully.(34)

1.1.8 Efficacy of microwave oven irradiation

An interest towards using physical disinfections has been improved with microwave irradiation. The reasons behind this shift were due to the cost and time consuming of daily preparation of chemical disinfectant solutions as well as soaking and drying of dental stone cast, apart from having a bad odor and the negative effects of these materials on physical and mechanical properties of stone casts.(35)

Microwave irradiation at 600 W for 3 min can be used to obtain high-level disinfection as a reliable alternative to conventional chemical disinfection techniques. That was the finding of Robati Anaraki et al.(35) when they investigated the effectiveness of disinfection using different energy levels of microwave irradiation on contaminated stone casts with three test microorganisms in comparison with a validated chemical technique.

Microwave irradiation exposure of 650 W for 5 min caused complete elimination of Candida albicans and Pseudomonas aeruginosa strains, while 650W for 7 min exposure eliminated Staphylococcus aureus completely.(36) The efficacy of microwave irradiation to disinfect gypsum casts and impressions was compared with chemical disinfectants, and concluded that microwave irradiation disinfection is effective in reducing microbial contamination of dental casts and is more effective than chemical solutions. They recommended the routine use of microwaves for disinfection of dental cast in order to prevent cross contamination between dental clinics and laboratories.

A study that investigated surface roughness and hardness of of dental stone after the use of sodium hypochlorite immersion or microwave irradiation, found that chemical disinfection with immersion in NaOCl 0.525% did not affect surface hardness. However it was surprising to find that microwave disinfection significantly reduced surface hardness of dental stone casts compared to the control group and NaOCl 0.525%.(37)

1.1.9 The effect of disinfection on the physical properties of impression materials

Dimensional stability and possible structural changes on the surfaces of impressions taken with alginate and PVS after disinfection with either 0.5% sodium hypochlorite (NaOCl) or 2% glutaraldehyde solutions was assessed by scanning electronic microscope. The results were as follows; firstly, the number of bacteria retained on the irreversible hydrocolloid samples was higher than on silicone impressions. Secondly, 10 minute immersion in 5% NaOCl or 2% glutaraldehyde was 100% successful in eliminating bacteria carried by the irreversible hydrocolloid and silicone impressions compared with the control group (non-disinfected impression samples). The SEM microphotographs exhibited no differences on the surface of the irreversible hydrocolloid and silicone treated with 0.5% NaOCl or 2% gluteraldehyde. In addition, their data also revealed that the silicone specimens immersed in both 5% NaOCl for 10 minutes and 2% glutaraldehyde for 5 and 10 minutes were able to completely eliminate the

bacteria absorbed onto the impressions. At the end they concluded that reducing immersion time can also minimize changes in physical properties such as dimensional stability and surface integrity while still being effective in disinfecting impressions.(38)

The effect of chemical disinfection, autoclave and microwave sterilization on the surface roughness of elastomeric impression materials (polyvinyl siloxane), found that putty and light-body impressions have significantly higher roughness values than heavy- and medium-body silicone materials. The authors concluded that autoclave sterilization of vinyl polysiloxane elastomeric impressions for 5 minutes at 134°C at 20 psi may be considered an effective method over chemical disinfection and microwave sterilization, because chemical disinfection does not eliminate all disease-causing microorganisms and microwave sterilization leads to a rougher impression surface.(39)

1.1.10 Efficacy of disinfection of dental stone casts

Gypsum products are widely used as materials for the preparation of models and casts in dentistry. Dental casts are transferred several times between the dental laboratory and the dental clinic. Bacteria and viruses can be transmitted from patients to the gypsum models during the fabrication of the prosthesis, if the plaster is poured into contaminated impressions or through contamination of bite blocks and trial bases. A microbiological analysis of dental casts was conducted to determine how long dental casts may pose a threat to the health of dental personnel and patients by assessing the numbers of microorganisms at different time intervals. The findings showed that microorganisms did not multiply in the gypsum casts; instead, their numbers significantly dropped.(40) Muslehifard et al.(41) compared the disinfection efficacy of sodium- hypochlorite and peroxygenic-acid (Virkon) solutions for dental stone casts contaminated with microbial strains. They recommended the use of Virkon as an antimicrobial disinfectant for dental stone casts based on its low toxicity and good environmental compatibility.

The effectiveness of microwave irradiation with different energy levels was compared to soaking stone casts in different concentrations of sodium hypochlorite solution at 1, 2 and 3 minutes.(35) The authors concluded that high level disinfection of stone casts can be achieved by microwave irradiation at 600 W in 3 minutes, similar to a validated chemical method.(42)

Microwave disinfection and ultraviolet light disinfection of Type III dental stone was conducted to compare the bactericidal efficacy of both techniques on gypsum blocks contaminated with Staphylococcus aureus and Pseudomonas aeruginosa, with the conclusion that microwave irradiation proved to be a better disinfection method for gypsum cast compared to Ultraviolet light disinfection.

The disinfectant efficacy of sodium hypochlorite (1 : 10) and iodophor on alginate impressions and on the gypsum cast, found that sodium hypochlorite (1: 10) preceded with water rinsing was the best disinfectant for disinfecting alginate impressions and the lowest number of bacterial colonies were found on dental casts made from these impressions. A negative culture was found after testing alginate impressions and their related gypsum casts after using four disinfectants namely Micro10, 2% Glutaraldehyde, 5.25% Sodium hypochlorite and Deconex in which all four disinfection solutions performed equally well.(43)

Perform ID (potassium peroxymonosulphate and sodium benzoate as active ingredients) solution was also tested as an immersion disinfection for alginate and addition-cured silicone impressions and resultant type III gypsum casts were tested for surface detail reproduction, surface hardness and abrasion resistance. It was found that perform-ID immersion disinfection adversely affected the surface detail reproduction of alginate, surface hardness of type III gypsum casts poured from alginate and the abrasion resistance of type III gypsum casts produced from a marketed ‘alginate alternative’ addition-cured silicone, Position Penta. No detrimental effect was found on President addition-cured silicone nor the resultant type III gypsum casts made from it.(44)

1.1.11 Non-toxic disinfectant

A product called Hypochlorousa is one of the most natural and effective known biocides known to man. It eradicates all bacteria, mycobacteria, spores, fungi, viruses within 15 seconds and disinfects 200 to 300 times better than bleach and is 100% safe. Hypochlorous acid oxidizes (explodes) the cell wall of all pathogens causing necrosis (rupturing of the cell) or apoptosis (programmed cell death) and destroys them. Though viruses are not technically living organisms, they too are destroyed by hypochlorous acid. Also it can be used for dental waterlines, impression disinfectant, instrument soak, ultrasonic baths, disinfect root canals, removing biofilms from implant surfaces, mouth rinse (particularly effective post-surgical), and endodontic irrigation.(45)

In a different way of controlling cross infection, several studies suggested to alternate the use of water in mixing irreversible hydrocolloid powder with chlorhexidine solution in order to benefit from its antibacterial effect. A randomized controlled clinical trial evaluated the microbial contamination, surface roughness and dimensional stability of casts made from impressions using irreversible hydrocolloid powder with chlorhexidine instead of water. As a result, they found decreased percentage of microorganisms with negative effects on surface quality or dimensional stability of the resulting casts.(46) Wang et al.(47) agreed that chlorhexidine in concentration of 1.0 g/L had an antibacterial effect. While a controversy was found with the study of Gupta where their results indicated the least effective method to be internal disinfection with less reduction in bacterial count and highest dimensional changes in comparison with the groups of spraying and immersion in chlorhexidine solution.(48)

1.1.12 Dentists' knowledge about infection control of dental impressions

The responsibility of ensuring impressions have been cleaned and disinfected before dispatch to the dental laboratory lies solely with the dentist.(49) The cross infection control knowledge of UK dentists was assessed by a questionnaire consisting of twenty questions.(50) The average

knowledge of general dentists on infection control was moderate. There was no significant difference in the average knowledge between dentists and the authors recommended greater emphasis on teaching infection control in dentistry on undergraduate courses and attending continuing education courses for dentists on a regular basis.

Another cross sectional survey tested knowledge and practice of disinfection.(51) with the conclusion that there was good knowledge of dental impression disinfection in the two tested institutions, because of the importance attached to infection control during the training of dental students, continuous training and updating of knowledge. On the other hand, a lack of commitment to the standards of infection control practices in dental colleges in India was found through a questionnaire survey conducted in 60 dental colleges throughout India, regarding dental impression disinfection. Only 75.9% of the 54 respondents washed impressions under running water, and only 24.1% of the respondents reported that impressions were treated by chemical disinfectants.(52)

It should be emphasized that it is the responsibility of the dentist to ensure impressions have been cleaned and disinfected before dispatch to the dental laboratory. Compliance with good practice is important and education in impression disinfection for both dentists and dental technicians is required.(49)

An assessment of current practice for disinfection of dental impressions in KSA governmental and private dental labs and prosthodontic clinics, reported that dentists are communicating with lab personnel about impression disinfection and found good awareness on infection control practices in dental laboratories. The sample included 50 dental technicians and 55 dentists in two cities. Furthermore, the majority of prosthodontists participating in the study routinely rinsed and disinfected the preliminary/ working impressions prior to sending them to the dental laboratory using immersion disinfectants.(53)

2. AIM

To determine the effectiveness of spray disinfectants used at Hamdan Bin Mohammed College of Dental Medicine (HBMCDM) for decontaminating impression materials.

OBJECTIVES

1. To compare the effectiveness of two types of spray disinfectants Bossklein (Silsden, W Yorks, BD20 0EF, UK) and MD520 (Dürr Dental, 74321 Bietigheim-Bissingen, Germany).
2. To compare the degree of decontamination of three different impression materials.

3. MATERIALS AND METHOD

3.1 Study design and location:

An experimental study design was used to evaluate the effectiveness of spray disinfectants on three dental impression materials. The swab specimens were collected randomly from impressions taken on patients attending dental clinics at Hamdan Bin Mohammed College of Dental Medicine (HBMCDM) in Dubai, United Arab Emirates.

3.2 Sample technique:

The following impression materials were swabbed:

- Alginate used in prosthodontic department (Tropicalgin, Zhermack)
- Alginate used in orthodontic department (Cavex orthotrace, Netherlands)
- Polyether (Impregum Penta, 3M ESPE)
- Polyvinylsiloxane (Express XT, 3M ESPE)

A sterile cotton swab "Amies transport medium" was used. Two swabs were taken for each impression. One immediately after rinsing under running tap water (pre-disinfection) and a second swab was carried out after spraying the disinfectant and rinsing under running tap water (post-disinfection).

3.3 Inclusion criteria:

- Maxillary and mandibular arches impressions made from alginate, polyether and polyvinylsiloxane (PVS) were swabbed from the gingival margin before spraying with the disinfectant and after spraying.
- Two spray disinfectants Bossklein (Silsden, W Yorks, BD20 0EF, UK) and MD520 (Dürr Dental, 74321 Bietigheim-Bissingen, Germany) were assessed for antimicrobial effectiveness. The second swab was taken 5minutes after applying Bossklein disinfectant and 10 minutes after applying MD520 disinfectant.

3.4 Exclusion Criteria:

- Other types of impression materials will be excluded and other impression disinfection techniques will be excluded.

3.5 Study Technique:

Maxillary or mandibular impressions taken randomly from patients who were attending prosthodontic and orthodontic clinics. Alginate (irreversible hydrocolloid), polyether and polyvinyl siloxane (PVS) were swabbed from the same gingival areas before and after spraying. Manufacturer's instructions were followed regarding the spray protocol for Bossklein which was to soak thoroughly and leave to dry naturally. To standardize the method of delivery, hand spraying only, MD520 was also used from a spray bottle as the gold standard but subsequently the Hygojet box system was not used as per manufacturer's direction. Swab specimen were collected twice for each impression. The first was taken immediately after the impression was removed from the patient's mouth and rinsing under tap water. The second swab was taken after 10 minutes when using MD520 and after 5 minutes when using Bossklein and after rinsing under running tap water.

Swabs were transported to the microbiology laboratory, MedLab, in Amies medium. All swabs were plated onto blood agar (Fig1) within 2 hours. Plates were incubated for 3 days at 37^{o}C then at room temperature for 3 days. After incubation, all plates were examined for microbial colony growth. The results were described as "no growth" when there was no microbial colony formation after incubation period and considered as "growth" when microbial colony was detected.

3.6 Feasibility Study:

- A feasibility study was conducted on alginate and polyvinylsiloxane by swabbing both impression materials; palate midline and the palatal gingival margin. A total of twelve specimens were taken, six were before applying disinfectant and another six 10 minutes after disinfection using the sterile swab and then was sent to Medlab for culture. The results were described as:

- Bacterial growth was present before disinfection from gingival swabs.

- No bacterial growth was present after disinfection for all specimens from gingiva

- No bacterial growth was present before and after for specimens taken from the palate only.

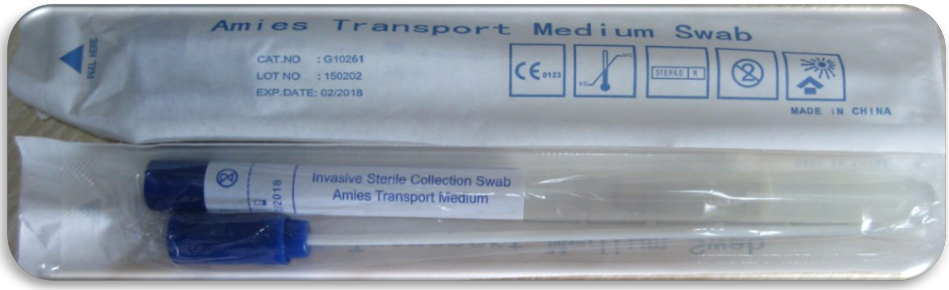

Fig 2: Amies transport medium swab used in the study.

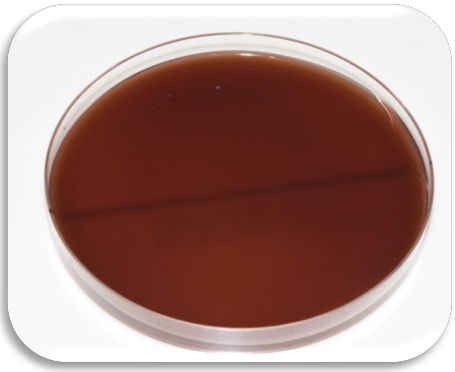

Fig 3: Blood agar plate with no bacterial colonization.

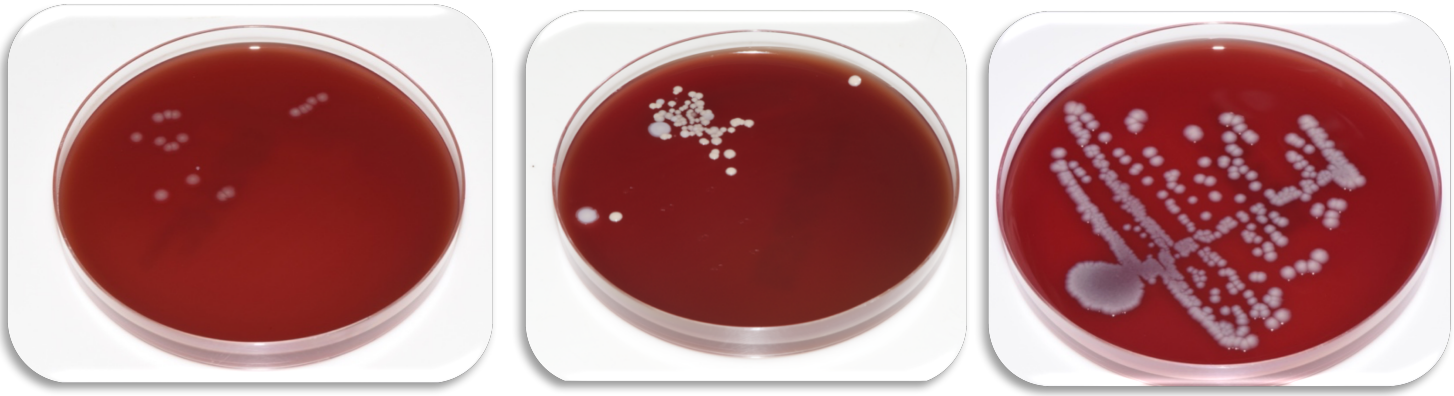

Fig 4: Blood agar plates with different degrees of bacterial colonization after incubation.

3.7 Statistical analysis method:

All data will be entered into SPSS v 20. The number of contaminated impressions before and after disinfection for each impression material was compared using the chi square test with the level of significance set at $p<0.05$.

4. RESULTS

Results are presented for pre- and post-disinfection for type of impression and type of disinfectant used.

Table 1 shows the presence or absence of bacterial growth according to impression material before disinfection. The number of contaminated polyether impressions pre-disinfection were significantly lower than with the other two impression materials ($x^2 = 7.75$, $p<0.05$).

Table 1: The presence of bacterial growth pre-disinfection according to the type of impression material.

		Impression material			Total
		Alginate	PVS	Polyether	
Pre-Disinfection	No growth	6 (14.6%)	1 (3.2%)	5 (33.3%)	12 (13.8%)
	Growth	35 (85.4%)	30 (96.8%)	10 (66.7%)	75 (86.2%)
Total		41	31	15	87

($x^2 = 7.75$, $p<0.05$)

The effect of disinfection on impression material is shown in Table 2. As can be seen 13 cases of bacterial growth were found after disinfection mainly on Alginate and Polyvinylsiloxane. Although this was not statistically significant it is clinically very relevant.

Table 2: The presence of bacterial growth post-disinfection according to the type of impression material.

		Impression material			Total
		Alginate	PVS	Polyether	
Post-disinfection	No growth	35 (85.4%)	25 (80.6%)	14 (93.3%)	74 (85.1%)
	Growth	6 (14.6%)	6 (19.4%)	1 (6.7%)	13 (14.9%)
Total		41	31	15	87

($x^2 = 1.27$, $p>0.05$, NSS)

Tables 3 and 4 show the bacterial growth pre- and post- disinfection according to disinfectant solution. The difference in bacterial growth on the number of impressions between the two disinfectant solutions was not statistically significant. Both spray disinfectants reduced the number of contaminated impressions but an important finding is that 20% of impressions which were disinfected with Bossklein spray, were still contaminated after disinfection.

Table 3: Pre-disinfection growth according to disinfectant.

		Disinfectant		Total
		MD520	Bossklein	
Pre-disinfection	No growth	6 (18.8%)	6 (10.9%)	12 (13.8%)
	Growth	26 (81.3%)	49 (89.1%)	75 (86.2%)
Total		32	55	87

($x^2 = 1.05$, $p>0.05$, NSS)

Table 4: Post-disinfection growth according to disinfectant.

		Disinfectant		Total
		MD520	Bossklein	
Post-disinfection	No growth	30 (93.8%)	44 (80.0%)	74 (85.1%)
	Growth	2 (6.3%)	11 (20.0%)	13 (14.9%)
Total		32	55	87

($x^2 = 3.01$, $p>0.05$, NSS)

Figure 5 is a graph illustration for tables 3 and 4.

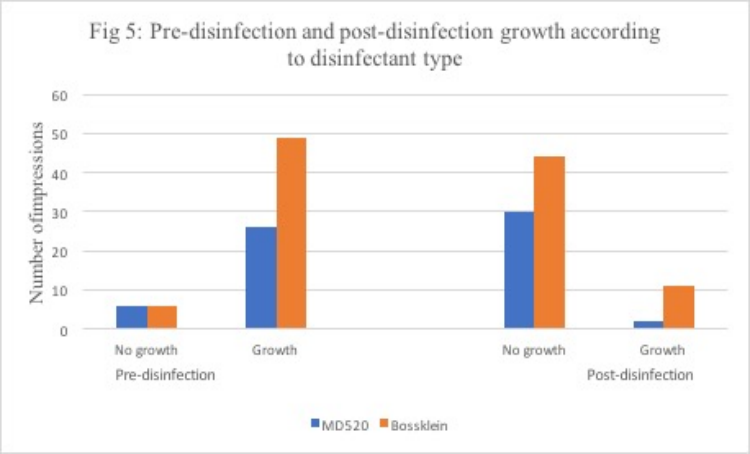

Table 5 shows the post-disinfection bacterial growth according to impression material and disinfectant solution. There was no growth after disinfection with MD520 on both PVS and Polyether impressions. Two Alginate impressions were still contaminated after disinfection with MD520. Disinfection with Bossklein, however, resulted in 6 impressions having growth on PVS and 4 had growth on Alginate with only 1 Polyether impression being contaminated. The occurrence of post-disinfection growth with Bossklein on PVS was significantly greater than expected (x^2= 5.37, $p<0.05$). Overall, the efficacy of Bossklein to disinfect impressions was inferior to MD520.

Table 5: Post-disinfection growth according to impression material and disinfectant.

Impression material			Disinfectant		Total	p
			MD520	Bossklein		
Alginate	Post-disinfection	No growth	12	23	35	NSS
		Growth	2	4	6	
	Total		**14**	**27**	**41**	
PVS	Post-disinfection	No growth	13	12	25	p<0.05
		Growth	0	6	6	
	Total		**13**	**18**	**31**	
Polyether	Post-disinfection	No growth	5	9	14	NSS
		Growth	0	1	1	
	Total		**5**	**10**	**15**	
Total	Post-disinfection	No growth	30	44	74	NSS
		Growth	2	11	13	
	Total		**32**	**55**	**87**	

5. DISCUSSION

As mentioned earlier, dentists and dental staff are exposed to a large number of microorganisms which are potentially harmful. These microorganisms can be transferred easily from the dental clinic to the lab through impressions, appliances and prostheses.

It has been shown that just rinsing impressions under running tap water is not satisfactory in removing microbes but rather it can significantly spread them over the surface of the impression material. Disinfection is therefore required .(30)

Recently, spray disinfectants have been introduced which provide good disinfection. Immersion techniques are effective, but unlike sprays dimensional stability is not adversely affected.(24)

Because of the importance of this area, this study was conducted to evaluate the effectiveness of two spray disinfectants (MD520 and Bossklein) on three types of impression materials (irreversible hydrocolloid, polyvinylsiloxane and polyether).

MD 520 solution is based on a range of antimicrobially active constituents including aldehydes, quaternary ammonium cations and special surfactants. 100 g MD 520 contains 0.5 g glutaraldehyde and 0.25 g alkyl benzyl dimethyl ammonium chloride as the active antibacterial agents. MD520 effectively disinfected all but 2 Alginate impressions in 10 minutes. This finding was in agreement with Egusa et al in 2008, who recommended it for clinical and laboratory use.(28),(30)

Bossklein impression disinfectant spray is composed of ethanol and didecyldimethyl ammonium chloride. No studies were found in the literature evaluating its effectiveness in disinfecting dental impressions. In a previous study that investigated similar alcohol-based solutions such as Dimenol and Perform-ID, it was found that they were comparable to solutions of chlorine or glutaraldehyde using either a spray or immersion technique.(28)

Similarly, Pakdin et al tested Micro10 (quaternary ammonium propionate), 2% Glutaraldehyde, 5.25% Sodium hypochlorite and Deconex and concluded that all can be used as an efficient disinfectant on alginate impressions. (43)

In agreement with our study results, Demajo et al compared MD 520 solution with Minuten and found that glutaraldehyde-based disinfectant (MD520) is more effective than alcohol-based disinfectants (Minuten), particularly when alginate is used as an impression material. They mentioned that alcohol action depends on surface friction, thus mechanical friction needs to be applied during disinfection. They did not recommend it as an impression disinfectant.(22) Similarly, another comparison, isopropyl alcohol together with povidine-iodine was found to be the least effective in decontaminating impression materials.(54)

The current study was conducted *in vivo* in order to mimic the real clinical situation and to identify any deficiencies with the disinfectant or the technique. Samples were taken from fully and partially dentate participants who were not having any orthodontic or prosthetic appliances that might affect the microbial flora. The results of the current study confirmed that irreversible hydrocolloid impression material harbored more organisms before disinfection than PVS and polyether impression materials. This result was in agreement with Demajo et al.(22) who found that irreversible hydrocolloid had higher microbial counts compared to silicone impression materials.

In the current study, a major finding was that 20% of tested impression materials disinfected with Bossklein solution were still contaminated after disinfection which indicates that it was not effective and need further investigation and testing as there was no other studies available to allow comparison with our results. Failure to adequately decontaminate impressions may be due to incorrect clinical procedure or poor disinfecting properties. As a direct result of this study all dental assistants and faculty staff will be trained to improve impression disinfection on the clinic.

5.1. Study limitations and recommendations:

- A more controlled technique should be advocated by standardizing the number of spray puffs.
- The blood agar plate used in our study, is a nonselective general purpose culture medium which is considered as a limitation because only aerobic microorganisms can be incubated. Anaerobes and viruses were not grown although they can be present on impression materials. Using other culture techniques and investigating the effectiveness of disinfectants against viruses and other bacterial species is recommended for further research.

6. CONCLUSION

Based on our findings, it can be concluded that all types of impression materials are contaminated after taking them out of patient's mouth and they can cause cross contamination. MD520 spray disinfectant solution used in the current study was able to disinfect the three types of impression materials but Bossklein was less effective with post-disinfection contamination on all three impression materials. Spray disinfection of dental impressions may not be as effective as immersion methods. Effective spray disinfection relies on correct operator technique such as thoroughness of soaking. A low number of trigger squeezes of spray bottles may be related to cost saving which is an issue immersion disinfectants do not have. Dental staff must be trained appropriately and understand that disinfection protocols differ.

Our study corroborates previous work showing that an alcohol based disinfectant is less effective than aldehyde based disinfectant.(22) However; more studies are needed for further evaluating Bossklein solution as no studies were found in the literature regarding its effectiveness.

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APPENDIX I:

Data collection sheet

Date	Patient' ID	Type of impression material (3)	Swab site Upper/lower	Type of disinfectant (MD520-Bossklein)	Specialty clinic	Operator Ayesha/Nurses	CFU/cm² before disinfection A	CFU/cm² after disinfection B

APPENDIX II

جامعة محمد بن راشد للطب والعلوم الصحية
MOHAMMED BIN RASHID UNIVERSITY OF MEDICINE AND HEALTH SCIENCES

Date: 30/09/2017

Dear Dr Ayesha Alshikh

Re: Your research protocol

Titled: Effectiveness of spray disinfectant on three dental impression materials.

Thank you for submitting your research protocol to the Research and Ethics committee of the Hamdan Bin Mohammed College of Dental Medicine, MBRU.

It was considered at the meeting held on: 21/05/2017

I apologise for the late reply.

There are 2 minor points raised by the committee. Please include a covering letter to the MediLab requesting collaboration for the cultures.

Ideally, sample size should be stated.

The committee decided that since this is a laboratory based study it does not need REC approval. Accordingly please go ahead with the study.

The committee would like to remind you that it is a requirement of the programme that you complete a research dissertation, which comprises 15% of credits within the 3-year MSc programme.

Wishing you every success with your project

Yours sincerely,

Prof A Milosevic

Chair, Research and Ethics Committee, HBMCDM

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