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Efficacy of various disinfectants on antimicrobial action and dimensional Stability of Elastomeric Impression Material

Upasana Tyagi [1], Neelu Jain [2*], Rama Kanta Mahapatro [3], Puvvala Vidyadhar [4], Rahul Kumar Anand [5], Shilpa Jain [6], Fahanna Beegum MS [7]

[1] Reader, Department of Public Health Dentistry, NIMS Dental College and Hospital, Jaipur, Rajasthan, India

[2]Associate Professor, Department of Microbiology, Bundelkhand Medical College, Sagar, MP, India

[3] Sen Lecturer, Department of Prosthodntics and Crown and Bridge, KIIT, Kalinga Institute of Dental Sciences, Deemed to be university, Patial, Bhubaneswar, Odisha, India.

[4] Senior Lecturer, Department of Prosthodontics, College of Dental Sciences and Hospital, Rau, Indore, MP, India

[5] Sen Lecturer, Department of Orthodontics, RKDF Dental College and Hospital, Bhopal, MP, India

[6] Professor, Department of Prosthodontics, College of Dental Sciences and Hospital, Rau, Indore, India

[7] Lecturer, Department of Preventive Dental Sciences, College of Dentistry and Pharmacy, Buraydah Private College, Buraydah-51418, Qassim, Kingdom of Saudi Arabia

***Corresponding author: Dr. Neelu Jain,** E-mail: jainneelu12@gmail.com

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Abstract

The current study set out to assess how three distinct disinfectants affected the elastomeric imprint material's dimensional stability and antibacterial activity. A consistent stainless steel master die was built in compliance with American Dental Association (ADA) specification number 19. Following the manufacturer's instructions, a total of thirty samples were made on this die using vinyl polysiloxanes (VPS) impression material. Thirty samples were randomly assigned to each of the three groups in order to complete the disinfection process: Group I was diluted water (control group), Group II was 5.25 percent sodium hypochlorite (NaOCl), and Group III was ozone gas. Utilising image investigation software and a stereomicroscope with a 20× magnification, the dimensional stability was assessed. Every disinfectant's antimicrobial effectiveness was evaluated. The control group showed the most dimensions changes in the VPS impression material, followed by 5.25% NaOCl and ozone gas, which showed the lowest dimensional changes. It was discovered that there were statistically considerable differences between the groups. The study's findings suggest that when immersed in various disinfectants, the VPS elastomeric imprint exhibited little dimensional changes. Samples disinfected with 5.25% hypochlorite can be stored for an extended period of time in a clinical setting because the resulting dimensional changes are negligible. Both sodium hypochlorite and ozone gas demonstrated a decrease in the number of germs.

Keywords

Disinfection, dimensional changes, Elastomeric impression, sterilisation

Introduction

The procedure of creating an impression is one that dentists use frequently, and it requires choosing the right tools and materials for the job. Following the creation of impressions, casts are obtained from the same and used to create a variety of appliances as study models or dies [1]. In order to create precise castings of oral anatomy, impression processes are necessary for a number of dental operations. Impression materials frequently come into touch with blood and saliva during the impression operation, which increases the risk of infection with infectious diseases including AIDS, herpes, hepatitis, or tuberculosis. Because dentists, oral hygienists, and dental laboratory personnel are frequently exposed to infectious diseases, it is imperative that impression materials be disinfected [2]. All impression materials should be sanitised before being sent to a laboratory, according to 1998 FDI rules [3].

More hydrophilic than other forms of impressions are polyethers, certain extra silicone compounds, and hydrocolloids, both reversible and irreversible. Since elastomeric impression

materials have good physical qualities, they are frequently chosen. A new generation of elastomeric imprint materials with superior mechanical and flow qualities is introduced: vinyl polyether silicones (VPES). Final impressions for edentulous patients are created using polyethers (PE) and VPS impression materials [4]. Polyvinylsiloxane, an addition silicone elastomeric impression material, is extensively utilised due of its superior dimensional accuracy and low distortion [2].

The usage of disinfectants should be on par with the efficacy of antimicrobial agents and should not compromise the impression material's dimensional correctness. It is recommended to use a variety of disinfectants to clean impression materials, including phenol, iodophor, glutaraldehyde, and sodium hypochlorite [2]. Chemical disinfection is a commonly used process that involves spraying or immersing the impression's surface in a chemical solution. The material needs to show dimensional stability both during the disinfecting process and while being stored till the cast is poured. Therefore, it is imperative that the impression material's dimensional changes be limited within permitted variances of 0–0.15% [1].

In order to mitigate the adverse effects of chemical agents on the various material qualities of dental impressions, scientists are exploring alternative disinfection techniques, including ozonated water, gaseous ozone, microwave irradiation, UV radiation, and ethylene oxide gas [5, 6]. Because of its hydrophilic qualities, using that substance via spray or immersion might distort impressions and result in dental casts, which can compromise the final product's accuracy [5].

While the oxygen we breathe is made up of two oxygen atoms, ozone is a gas made up of three oxygen atoms. Ozone is a potent steriliser due to its great instability and high reactivity. Furthermore, ozone is a strong oxidizer that can damage microorganisms' DNA in addition to their cell membranes and intracellular enzymes [7]. Ozone water has been recommended as a clinical substitute for 5.25% NaOCl and 2% glutaraldehyde when disinfecting silicone impression materials [8].

Disinfectants may change the dimensional accuracy of imprint materials, according to certain theories [2]. Therefore, the goal of the current study was to assess how three distinct disinfectants affected the elastomeric imprint material's dimensional stability and antibacterial activity.

Materials and method

The Department of Microbiology and the Department of Prosthodontics conducted the current investigation. A consistent stainless steel master die was built in compliance with American Dental Association (ADA) specification number 19. Following the manufacturer's instructions, a total of thirty samples were made on this die using vinyl polysiloxanes (VPS) impression material. Thirty samples were randomly assigned to each of the three groups in order to complete the disinfection process: Group I was diluted water (control group), Group II was 5.25 percent sodium hypochlorite (NaOCl), and Group III was ozone gas.

The mould was made up of a base that had two vertical and three horizontal lines, each measuring 0.050 mm in width, carved into it perpendicularly. After the elastomers were loaded, pressure was applied using a perforated steel plate and a precisely positioned steel ring with an internal diameter of 3.8 mm on the base. The metal ring was first positioned on the mold's base by directly injecting light body material into the platform. After that, tray material was combined and loaded in accordance with manufacturer guidelines. Perforation was used to remove extra material. To imitate oral conditions, the specimens were placed in a water bath with a thermostat controlled at 37°C. A total of thirty specimens were created, ten for each group of materials. Following sample fabrication, the distance (0.005 mm) between the inner profiles of the horizontal line was measured under a microscope both before and after each disinfectant was applied. The formula used to calculate the percentage of dimensional change was dimensional change % = (A-B)/A 100, where "A" represents the distance between the horizontal line's inner profile prior to disinfection and "B" represents the distance following the disinfection process. Utilising image investigation software and a stereomicroscope with a 20× magnification, the dimensional stability was assessed.

Thirty impression of the patients jaw were made and were subjected for antimicrobial efficacy before and after disinfection with 3 different disinfectants. Swab from molar area of each elastomeric impression was collected before and after disinfection and it was incubated in nutrient agar media for 24 hours at 37^0C. Using a colony counter, the microbial colony count was performed after a 24-hour period.

The obtained data was statistically evaluated using SPSS software version 22.0 with $p<0.05$ using ANOVA test.

Result

The control group showed the most dimensions changes in the VPS impression material, followed by 5.25% NaOCl and ozone gas, which showed the lowest dimensional changes. ANOVA revealed that there were statistically significant differences between the groups, with a p-value of less than 0.001 (Table 1).

Table 1: Analysing the average dimensional stability both prior to and during disinfection

Disinfectant group	Before (mean ±SD)	After (mean ±SD)	Dimensional changes	F value	p
I.Control group (Distilled water)	0.12±0.02	0.94 ± 0.12	0.82 ±0.10	7.319	0.001
II. Sodium hypochlorite	0.12± 0.06	0.65±0.15	0.53±0.09		
III. Ozone gas	0.11 ±0.04	0.56±0.16	0.45±0.12		

Table 2: Total bacterial count (CFU/ml), before and after disinfection

Disinfectant group	Before (mean)	After (mean)	p
I.Control group (Distilled water)	8.76×10^5	6.46×10^5	0.001
II. Sodium hypochlorite	8.87×10^5	1.36×10^4	
III. Ozone gas	8.81×10^5	1.61×10^4	
F value	0.241	174.021	

Table 2 indicates that there was significant reduction in bacterial count in group II and III but least reduction with control group (Group I). The difference was statistically significant from pre to post disinfection.

Discussion

A negative representation of the human dentition's teeth and soft and hard oral tissues is created using dental imprints [5]. After creating an imprint, precise replication of the oral structure's surface details is essential. To prevent cross-infection, impression materials should be disinfected [2]. There are two primary procedures for disinfecting impressions: immersion and spraying. While the immersion method covers all surfaces but isn't optimum, the spray method doesn't fully expose the contaminated surface and undercuts to the antimicrobial agent [9].

When utilised as impression resources, elastomers exhibit dimensional unsteadiness due to partial elastic revival following deformation, temperature fluctuations, or polymerization shrinkage discharge of byproducts from chemical reactions [1].The study's findings suggest that when immersed in various disinfectants, the VPS elastomeric imprint exhibited little dimensional changes.

Various measurement methods are applied to ascertain the dimensions alterations during disinfection. Travelling microscopes are used in certain studies. Direct measurements of dimensional stability and accuracy could be made using stone casts or impressions [4, 10].

After immersing vinyl polysiloxanes (VPS) and polyethers (PE) in two distinct disinfectants—a 2% glutaraldehyde (GA) group and a 5.25% sodium hypochlorite (NaOCl) group—Almuraikhi's investigation revealed that the materials exhibited little dimensional alterations [1]. The dimensional accuracy of elastomeric imprint materials was assessed by Kamble et al. using the autoclave, chemical, and microwave methods as disinfectants. They came to the conclusion that all disinfecting techniques result in slight dimensional changes in the imprint material. They claimed that as compared to the autoclave and microwave methods, chemical disinfection results in less dimensional alterations [2]. Two elastomeric impression materials, vinyl siloxanether (VSE) and polyvinyl siloxane (PVS), were treated to chemical immersion and microwave irradiation for disinfection. Mohd et al. assessed and compared the dimensional stability of these materials. They came at the conclusion that under both chemical immersion and microwave irradiation, VSE showed better dimensional stability than PVS. In therapeutic situations, microwave irradiation with standard microwave ovens can be utilised in place of other disinfection methods [11].

The effectiveness of ultraviolet C (UVC) radiation, gaseous ozone, and commercial liquid chemicals for the disinfection of silicone dental impressions was assessed by Wezgowiec et al.

They came to the conclusion that while all tested treatments are effective, each disinfectant needs to be evaluated independently [5].

Pal et al assessed the Type IV gypsum casts' dimensional stability and surface quality after removing them from sanitised elastomeric impression materials. They came to the conclusion that none of the three disinfectants affected the replication of surface details and all three generated complete disinfection [12]. Karaman et al. evaluated how long an elastomeric impression material's surface was roughened by applying sodium hypochlorite and a disinfectant solution based on quaternary ammonium. They came to the conclusion that the surface roughness of the light body elastomeric impression material significantly increased with prolonged application of the sodium hypochlorite disinfectant at 1% and 5% concentrations [13].

In current research, Sodium hypochlorite and ozone gas had good antimicrobial effect and least with control group.

On dental impressions created with condensation silicone, Nagi et al. assessed and contrasted the disinfectant efficacy of a herbal formulation that is commercially available (HiOra®) with 1% sodium hypochlorite and 0.2% chlorhexidine digluconate solution. They came to the conclusion that the three disinfectants tested had similar antimicrobial efficacy against both Streptococcus and Staphylococcus species, and that herbal mouthwash was just as effective at disinfecting impressions made from condensation silicone as sodium hypochlorite and chlorhexidine [14]. Trivedi et al. discovered that after immersing P. aeruginosa, S. aureus, and C. albicans in aloe vera for three minutes and spray disinfecting for three minutes, there is a mean percentage drop in colony count. full eradication of all microbe cells following a 7-minute immersion and spray disinfection [6].Ahirwar et al. assessed how well spray disinfectants worked against oral bacteria on alginate, an irreversible hydrocolloid imprint material. They came to the conclusion that alginate imprints can be successfully disinfected using spray disinfectants containing 0.5% sodium hypochlorite and 2% glutaraldehyde [9]. In three time intervals, Soganci et al. measure and contrast the dimensional changes of vinyl polyether siloxane impression materials and polyether impression materials under immersion disinfection with two distinct disinfectants. They came to the conclusion that the two impression materials' dimensional accuracy and stability were outstanding and comparable [4].

Using irreversible hydrocolloid, Rathod et al. assessed the antimicrobial qualities of a produced herbal solution on dental impressions. This research is a comparative ex vivo

investigation. They came to the conclusion that using a herbal disinfectant solution to inhibit bacterial growth on impressions containing irreversible hydrocolloid is successful [15].

This study's limitations include the fact that it was conducted in vitro and that the imprints made and removed were not the same as those made in clinical settings. Additional investigation is required to validate the results.

Conclusion

The study's findings suggest that when immersed in various disinfectants, the VPS elastomeric imprint exhibited little dimensional changes. Samples disinfected with 5.25% hypochlorite can be stored for an extended period of time in a clinical setting because the resulting dimensional changes are negligible. The antibacterial activity of sodium hypochlorite was highest in the ozone gas group and lowest in the control group.

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