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Comparative Evaluation of Different Disinfectant Methods on Dimensional Accuracy of Elastomeric Impression Materials – An In Vitro Study

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Abstract

Purpose: This study presents comparison and assessment of the dimensional changes of two elastomeric impression materials after subjecting them to four disinfection methods.

Materials and Methods: Two elastomeric impression materials: Polyvinylsiloxane (Reprosil – Medium body) and Polyether (Impregum – medium body), were used. A standardized stainless-steel master die as per ADA specification no.19 was fabricated. Special trays were fabricated on the stainless-steel die with auto-polymerizing acrylic material. Impression materials were mixed according to the manufacturer's instructions and were loaded into the impression trays to make an impression of the die. Different disinfectant methods were: Autoclave, Microwave irradiation, UV light, and Chemical disinfection by CIDEX

(2% glutaraldehyde). Impressions were disinfected for 10 minutes by each method. Measurements were made with a stereomicroscope before and after disinfection, and the data was analyzed.

Results: Statistically significant dimensional changes were observed with all the disinfectant methods except UV light disinfection for both the elastomers. But these linear dimensional changes were within ADA standards (0.5%) except for microwave disinfection of Polyether (0.6%).

Conclusion: Within this study's limitations, it can be concluded that UV light disinfection showed the least dimensional changes with both the elastomeric impression materials.

Keywords: Autoclave, CIDEX, Microwave irradiation and UV light disinfection.

Introduction

Impressions and impression-making procedures form a massive part of dental practices. Dental impressions come in contact with the patient's blood and saliva. The microorganisms present in a patient's blood and saliva contaminate the impressions. They can transmit infectious diseases like HIV, Herpes, and Hepatitis B. These impressions pose a threat of disease transmission to dental health care workers, laboratory, and transporting personnel through direct or indirect contact. With the pandemic of COVID – 19, it has become an absolute mandate to disinfect the impressions before pouring them or sending them to the laboratory. The American Dental Association (ADA) recommends immediate disinfection of dental impressions immediately after removing from the patient's mouth to prevent cross-infection between the patients and dental staff in dental offices and laboratories. [1] Numerous methods of disinfection are used to disinfect different impression materials. Of which, the most commonly used method is the chemical method. Chemical disinfection includes the application of disinfectant to the impression surface either by spraying or immersion. But this procedure is effective against organisms in vegetative forms but not bacterial spores. [2–3] Various concentrations of glutaraldehyde (0.5%, 2%, 2.2%, and 2.45%), sodium hypochlorite (NaOCl) (0.5%, 0.525%, 1%, 4% and 5.25%), chlorine compounds (0.2% chlorhexidine) iodophors (5% and 10%), phenols (7%), and hydrogen peroxide (0.5%) are used. Among these, sodium hypochlorite and glutaraldehyde are widely used. Physical disinfection methods act by increasing temperature and include autoclave, microwave irradiation, and UV light disinfection. The purpose of this in vitro study is to compare and evaluate dimensional changes of two elastomeric medium body impression materials after subjecting them to four disinfection methods.

Materials and Methodology

This study was conducted on two commercially available medium-body elastomeric impression materials: Polyvinylsiloxane (Reprosil) and Polyether (Impregum). Four disinfection methods (Autoclave, Microwave, UV light, and 2% glutaraldehyde) were used. The total sample size taken was 80 and were divided into different groups: (Figure 1).

A. Die Specifications: A standardized stainless-steel die was fabricated according to ADA specification no.19 and ISO International standard 4823 guidelines. The die consisted of a base scored with three horizontal lines perpendicular to two vertical lines, each 5 mm wide. The internal diameter of the die was 30 mm, the external diameter was 38mm, and the height was 6mm.

B. Tray Specimens: The special trays were fabricated on the stainless-steel die with auto-polymerizing acrylic material (DPI RR Cold Cure). A 2mm wax-spacer was placed on the die before fabricating the trays to provide space for impression material. Perforations are made equidistantly with a 701-carbide bur to aid in mechanical retention between the try and impression material. In addition, manufacturer-specific adhesives - Caulk VPS tray adhesive (Dentsply) and 3M ESPE Polyether adhesive were used for Polyvinylsiloxane and Polyether impression materials, respectively. One coat of tray adhesive was painted onto the tray surface and was allowed to dry for 15 minutes before loading the impression material. A handle of 4mm x 4mm x 2mm dimensions was placed on the opposite side for easy handling and removing the special tray.

C. Impressions: Equal amounts of base paste and catalyst paste were taken on a clean glass slab and were mixed with a spatula. The proportioning and mixing of the impression material was carried out as per the manufacturer's recommendations. After mixing, the impressions were loaded on the special trays and were placed on the die. Following the complete set of the impression materials, the trays were removed from the die. Then the impressions were inspected. The distance between the inner profiles of the horizontal line was measured before disinfecting the impressions with a stereomicroscope.

D. Disinfection: Impressions were disinfected by placing them in an autoclave, microwave, and UV chamber for 10 minutes. Steam autoclaving was done at 121ºC at 15psi and for 10 minutes. Microwave irradiation of impressions was done in a microwave oven at 10 minutes/720 W. For UV light disinfection, a dental UV chamber of 254nm was used. For chemical disinfection, the impressions were immersed in 2% glutaraldehyde for 10 minutes. The distance between the inner profiles of the horizontal line was again measured as previously with a stereomicroscope.

Results

Data analysis was done using Statistical Package for the Social Sciences (SPSS) version 15.0, the statistical analysis software. Paired "t" tests were done to compare values before and after disinfection for both the impression materials. In both the impression materials, significant dimensional changes (p-value <0.05) were seen with all the disinfectant methods except UV light disinfection (Table 1).

The percentage of linear dimensional change was measured using the formula; dimensional change % = (A – B)/A x 100, where "A" is the distance between the inner profile of the horizontal line before disinfection and "B" is after disinfection procedure. The percentage linear dimensional change of both the elastomers before and after disinfection was presented (Table 1). Disinfection with autoclave, microwave, and UV light resulted in a contraction, while with 2% glutaraldehyde resulted in an expansion. % Linear dimensional change for Polyether by microwave disinfection (0.61%) was beyond ADA standards (0.5%) (Graph1).

The mean and standard deviation of the measurements were presented (Table 2). ANOVA comparison was done to compare each disinfectant method for both the impression materials. The results showed statistically significant (p-value <0.05) differences among the four disinfectant methods.

Post-hoc Scheffe's test was done to analyze pair-wise comparisons (Table 3). The results showed that there was a significant difference between each of the disinfectant methods. This significance was not seen between autoclave and microwave, and autoclave and UV light in Polyvinylsiloxane impression material. This significance was also not seen between autoclave and microwave in Polyether impression material.

Discussion

Dental impressions are considered semi-critical objects and require high-level disinfection or sterilization. [4] Until 1991, the procedure followed for disinfection of impression was rinsing under running water. This practice removed only 40% of bacteria, viruses, and fungi, and the potential for transmission of infections was present. [5] Lately, a pre-wash of the impression with running water is done to remove all particles, blood, and saliva before the active disinfection procedure. [6] Disinfection of dental impression should be a mandatory procedure in the dental office laboratory.

The rationale behind the current study was to determine the best feasible disinfection method for elastomeric impression materials. The most commonly used elastomeric impression material in dental practice is polyvinylsiloxane (VPS). Along with it, polyether impression material was also evaluated. Both the impression materials were used in medium-body consistency. This is because medium-body elastomers can be used both as tray materials and syringe materials. [7]

Over a while, various methods of disinfection of impression materials have been developed. Among these methods, the chemical method is the most frequently used. Other methods include steam autoclave, microwave irradiation, UV light radiation ozone, and electrolyze-oxidized water. In the present study, four disinfection methods were evaluated.

Sterilization refers to the complete elimination of all microorganisms both in vegetative and spore forms. The most common method of sterilization employed by dental practitioners is steam-autoclaving. The principle of autoclave is moist heat sterilization, where steam under pressure is used to sterilize the material present inside the chamber. When this steam comes in contact with the surface, it kills the microbes by giving off latent heat. [9] Holtan et al. reported polyvinylsiloxane impression material could be autoclaved without any significant dimensional changes using stock metal trays. Although it should be cautiously done when sterilizing at 132˚C.[10] Millar et al. in their study showed that addition-cured silicone impressions autoclaved at 134˚C produced less than 0.5%-dimensional change. [11]

An alternative method of sterilization is microwave irradiation. Microwaves disrupt cell membrane integrity and cell metabolism, which ultimately leads to microbial death. [5] Goel et al. reported better disinfection by microwave irradiation than by using 0.7% NaOCl chemical disinfection. [13] Microwaves are inexpensive, easy to use and provide adequate disinfection. Choi et al. in their study, reported that polyvinylsiloxane impression materials could be disinfected in microwaves without any physical changes. [14] Microwave irradiation at 10 minutes/720 W has little effect on the accuracy of impressions, is recommended as a suitable technique for sterilizing rubber impressions. [15]

UV Light radiation, which has been introduced recently, is another way of disinfecting impression materials. UV light has a powerful bactericidal effect. It acts directly on the DNA of the bacterial cells resulting in their destruction. Godbole et al. used radiation of 254 nm wavelength to disinfect vinyl polysiloxane for 10 min.[15] Aeran et al. used a similar wavelength (254 nm) to disinfect alginate, addition silicone, and Polyether for 3, 6, 10, and 15 min and concluded that 3 min exposure to UV rays was sufficient for complete disinfection of Polyether. [16]

Glutaraldehyde is a high-level disinfectant and can destroy all types of microorganisms, including bacterial and fungal spores, tubercle bacilli, and viruses. [18] 2% glutaraldehyde is known as CIDEX and is a colorless liquid with a pungent odor. Special precautions are needed while using it: wearing butyl or nitrile gloves, a closed system for solution handling, exhaust ventilation of the places of handling, and keeping the temperature of the solution low as it will reduce the airborne concentration of the solution. [19]

The microwaving method showed the highest dimensional changes followed by chemical disinfection and steam autoclaving in the present study. These findings were similar to those by Ramakrishna et al. and Petrie et al.[20] No significant difference in dimensional changes were seen in both the impression materials when disinfected with UV light. Significant dimensional changes were seen with all the other disinfectant methods in both the impression materials. A linear contraction was observed with autoclaving, microwave radiation, and UV light disinfection. In contrast, a linear expansion was seen with the chemical method of disinfection for both the impression materials. These findings were similar to those by Kamble et al.[22]

Dimensional changes observed with autoclave and chemical disinfection were below ADA standards (<0.5%) for both the impression materials. Dimensional changes observed with microwave irradiation were below ADA standards (0.5%) for polyvinylsiloxane but were beyond ADA standards (0.6%). This could be because of the elimination of excess fluid in the microwave and the dry nature of the microwave heating atmosphere. Polyether being a hydrophilic impression material, showed this difference in microwave disinfection. While poly vinyl siloxane being hydro phobic, didn't show this effect. In the present study, UV light disinfection didn't show any significant dimensional changes for both the impression materials. Hence it can be used as a viable method in disinfecting elastomeric impression materials.

Limitations

1. As it is an in vitro study, it could not simulate the oral mucosal conditions.
2. Other properties like surface roughness should be investigated.

Conclusions

Within the study's limitations, it can be concluded that

1. UV Light Disinfection showed the most negligible dimensional changes for both Polyether and polyvinyl siloxane.
2. All disinfectant methods showed significant linear dimensional changes but are within ADA standards (0.5%) except microwave disinfection of Polyether (0.61%).

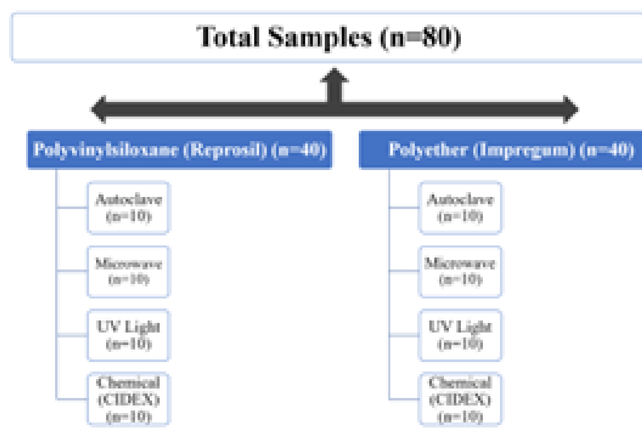


Fig 1: Schematic representation of distribution of samples

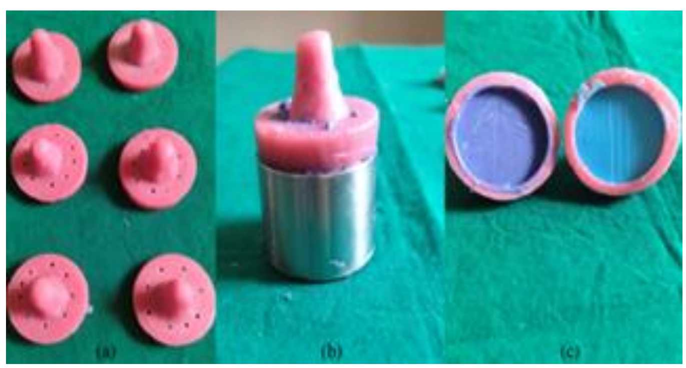


Fig 2: (a) Autopolymerizing acrylic tray samples (b) Making the impression (c) Impression samples

Table 1: Comparison of dimensional change before and after disinfection by Paired "t" Tests

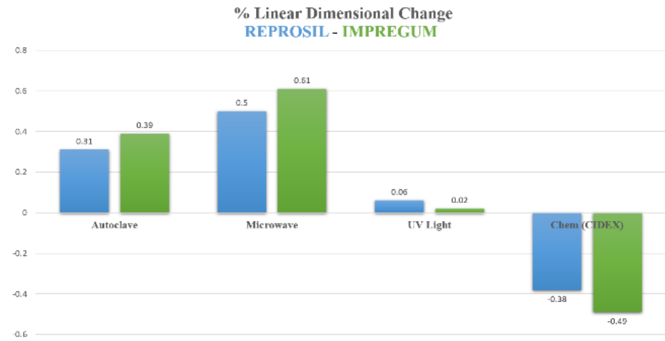
Table 1: PAIRED "t" Tests			
POLYVINYLSILOXANE (REPROSIL- MEDIUM BODY)			
Disinfection	t-value	p-value	Inference
Autoclave	-3.1393	<0.05	Significant
Microwave	-5.7888	<0.05	Significant
UV light	-0.8407	0.4222	Insignificant
Chem (CIDEX)	5.4583	<0.05	Significant
POLYETHER (IMPREGUM - MEDIUM BODY)			
Disinfection	t-value	p-value	Inference
Autoclave	0.009	<0.05	Significant
Microwave	-8.2425	<0.05	Significant
UV light	-2.236	0.5218	Insignificant
Chem (CIDEX)	5.7067	<0.05	Significant

Table 2: Comparison of four Disinfection methods by One – way ANOVA test

Table 2: ANOVA Comparisons					
POLYVINYLSILOXANE (REPROSIL - MEDIUM BODY)					
Disinfection	Mean (in mm)	SD	f-ratio	p-value	Inference
Autoclave	2.501	0.0053	44.0477	<0.05	Significant
Microwave	2.4951	0.006			
UV light	2.5057	0.0042			
Chem (CIDEX)	2.5197	0.0043			
POLYETHER (IMPREGUM - MEDIUM BODY)					
Disinfection	Mean	SD	f-ratio	p-value	Inference
Autoclave	2.4965	0.0081	22.2076	<0.05	Significant
Microwave	2.394	0.0056			
UV light	2.5054	0.0035			
Chem (CIDEX)	2.5154	0.0078			

Table 3: Post-hoc Scheffe Comparison between different disinfection method in Polyvinyl siloxane and Polyether impression materials

Table 3: Post Hoc Scheffe Test			
POLYVINYL SILOXANE (REPROSIL - MEDIUM BODY)			
TREATMENT PAIRS	TT-statistic	p-value	Inference
Autoclave vs Microwave	2.6399	0.0913859	insignificant
Autoclave vs UV light	2.103	0.2378856	insignificant
Autoclave vs Chem (CIDEX)	8.3671	1.45E-08	** p<0.01
Microwave vs UV light	4.7428	0.000506	** p<0.01
Microwave vs Chem (CIDEX)	11.007	1.30E-11	** p<0.01
UV light vs Chem (CIDEX)	6.2641	6.24E-06	** p<0.01
POLYETHER (IMPREGUM - MEDIUM BODY)			
TREATMENT PAIRS	TT-statistic	p-value	Inference
Autoclave vs Microwave	0.8583	0.8639581	insignificant
Autoclave vs UV light	3.0554	0.0382189	* p<0.05
Autoclave vs Chem (CIDEX)	6.4884	3.24E-06	** p<0.01
Microwave vs UV light	3.9136	0.0047866	** p<0.01
Microwave vs Chem (CIDEX)	7.3466	2.66E-07	** p<0.01
UV light vs Chem (CIDEX)	3.433	0.0159452	* p<0.05



Graphs 1: Schematic representation of Percentage Linear Dimensional Change after disinfection

References

1. Infection control recommendations for the dental office and the dental laboratory. ADA Council on Scientific Affairs and ADA Council on Dental Practice. J Am Dent Assoc. 1996 May; 127 (5): 672-80. doi: 10.14219/ jada. archive.1996.0280. PMID: 8642147.
2. AL Zain S. Effect of chemical, microwave irradiation, steam autoclave, ultraviolet light radiation, ozone and electrolyzed oxidizing water disinfection on properties of impression materials: A systematic review and meta-analysis study. Saudi Dent J. 2020 May;32 (4): 161-170. doi: 10.1016 /j. sdentj.2019.12.003. Epub 2019 Dec 23. PMID: 32405219; PMCID: PMC7211894.
3. Melilli D, Rallo A, Cassaro A, Pizzo G. The effect of immersion disinfection procedures on dimensional stability of two elastomeric impression materials. J Oral Sci. 2008 Dec;50(4):441-6. doi: 10.2334/josnusd.50.441. PMID: 19106472.
4. Rutala WA. APIC guideline for selection and use of disinfectants. 1994, 1995, and 1996 APIC Guidelines Committee. Association for Professionals in Infection Control and Epidemiology, Inc. Am J Infect Control. 1996 Aug;24 (4): 313-42. doi: 10.1016/ s0196-6553 (96) 90066-8. PMID: 8870916.
5. Chidambaranathan AS, Balasubramanium M. Comprehensive Review and Comparison of the

Disinfection Techniques Currently Available in the Literature. J Prosthodont. 2019 Feb;28(2): e849-e856. doi: 10.1111/ jopr.12597. Epub 2017 Apr 19. PMID: 28422353.

6. Correia-Sousa, Joana; Tabaio, Ana Margarida; Silva, Andrea; Pereira, Tânia; Sampaio-Maia, Benedita; Vasconcelos, Mário (2013). The effect of water and sodium hypochlorite disinfection on alginate impressions. Revista Portuguesa de Estomatologia, Medicina Dentária e Cirurgia Maxillofacial, 54(1), 8–12. doi: 10.1016/j.rpemd.2012.12.003

7. Tjan AH, Nemetz H, Nguyen LT, Contino R. Effect of tray space on the accuracy of monophasic polyvinylsiloxane impressions. J Prosthet Dent. 1992 Jul;68(1):19-28. doi: 10.1016/0022-3913(92)90278-i. PMID: 1403906.

8. Hemalatha, R., & Ganapathy, D. Disinfection of dental impression: A current overview. Int J Pharm Sci Res;2016;7(8):661-64.

9. Mallick, Atiquddin & Khaliq, Dr. Sheikh Abdul & Nasir, Muhammad & Qureshi, Rehan. (2014). PRACTICES OF STERILIZATION TECHNIQUES AT DENTAL CLINICS OF KARACHI, PAKISTAN. International Journal of Pharmacy. 4. 108-112.

10. Holtan JR, Olin PS, Rudney JD. Dimensional stability of a polyvinylsiloxane impression material following ethylene oxide and steam autoclave sterilization. J Prosthet Dent. 1991 Apr;65(4):519-25. doi: 10.1016/0022-3913(91)90292-5. PMID: 2066889.

11. Millar, B.J. (1999) Dimensional Stability of Additional Cured Silicone Impressions Following Autoclave Sterilization. Journal of Dental Research, 78, 297.

12. Millar, B. and Deb, S. (2014) Effect of Autoclave Sterilisation on the Dimensional Stability and Tear Strength of Three Silicone Impression Materials. Open Journal of Stomatology, 4, 518-526. doi: 10.4236 /ojst.2014.412069.

13. Goel K, Gupta R, Solanki J, Nayak M. A comparative study between microwave irradiation and sodium hypochlorite chemical disinfection: a prosthodontic view. J Clin Diagn Res. 2014 Apr;8(4): ZC42-6. doi: 10.7860 /JCDR/ 2014/ 8578.4274. Epub 2014 Apr 15. PMID: 24959515; PMCID: PMC4064919.

14. Choi, Yu-Ri; Kim, Kyoung-Nam; Kim, Kwang-Mahn (2014). The disinfection of impression materials by using microwave irradiation and hydrogen peroxide. The Journal of Prosthetic Dentistry, 112 (4), 981–987. doi: 10.1016/ j. prosdent. 2013.12.017

15. Abdelaziz KM, Hassan AM, Hodges JS: Reproducibility of sterilized rubber impressions. Braz Dent J 2004; 15:209-213

16. Godbole SR, Dahane TM, Patidar NA, Nimonkar SV. "Evaluation of the Effect of Ultraviolet Disinfection on Dimensional Stability of the Polyvinyl Silioxane Impressions." an in-Vitro Study. J Clin Diagn Res. 2014 Sep;8(9): ZC73-6.

17. Aeran H, Sharma S, Kumar V, Gupta N. Use of Clinical UV Chamber to Disinfect Dental Impressions: A Comparative Study. J Clin Diagn Res. 2015 Aug; 9 (8): ZC67-70. doi: 10.7860 / JCDR/ 2015 /14025.6353. Epub 2015 Aug 1. PMID: 26436051; PMCID: PMC4576645.

18. Gorman SP, Scott EM, Russell AD. Antimicrobial activity, uses and mechanism of action of glutaraldehyde. J Appl Bacteriol. 1980 Apr;48 (2): 161-90. doi: 10.1111 /j.1365-2672. 1980.tb01217. x. PMID: 6780502.

19. Takigawa T, Endo Y. Effects of glutaraldehyde exposure on human health. J Occup Health. 2006 Mar;48(2):75-87. doi: 10.1539/joh.48.75. PMID: 16612035.

20. Rama Krishnaiah R, Kheraif AA, Qasim SS. The effect of chemical disinfection, autoclave, microwave sterilization on the dimensional accuracy of polyvinylsiloxane elastomeric impression materials. World Appl Sci J 2012;17 (1):127-32

21. Petrie CS, Walker MP, O'Mahoney AM, Spencer P. Dimensional accuracy and surface detail reproduction of two hydrophilic vinyl polysiloxane impression materials tested under dry, moist, and wet conditions. J Prosthet Dent. 2003 Oct;90(4):365-72. doi: 10.1016/s0022-3913(03)00515-8. PMID: 14564291.

22. Kamble SS, Khandeparker RV, Somasundaram P, Raghav S, Babaji RP, Varghese TJ. Comparative Evaluation of Dimensional Accuracy of Elastomeric Impression Materials when Treated with Autoclave, Microwave, and Chemical Disinfection. J Int Oral Health. 2015 Sep;7(9):22-4. PMID: 26435611; PMCID: PMC4589713.