Published online: 2019-09-16

Original Article

Influence of chloramine-T disinfection on elastomeric impression stability

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ABSTRACT

Objective: The aim of this study was to evaluate the stability of elastomer through detail reproduction and its dimensional stability (DS) after disinfection with 0.2% chloramine-T. **Materials and Methods:** The elastomeric impression dental materials used in this study were polydimethylsiloxane (Oranwash L), polyvinyl siloxane (Express), polysulfide (Permlastic), and polyether (Impregum Soft). The entire press procedure was performed on a matrix in accordance with the ISO 4823. Detail reproduction was analyzed using an optical microscope (Stereozoom Microscope) over the 20-µm line with 25 mm of length at a magnification of ×4. DS was measured using an optical microscope (Scanning Tunneling Microscope) by subtracting the distance between the lines X and X' over the 20-µm line on the matrix (DM) from the distance between the lines on the impression material (DI) divided by DM and multiplied by 100 establishing the equation: DS = ([DI – DM]/DM) ×100; then, 100% was added to the results of the equation. The detail reproduction values were subsequently subjected to descriptive analysis by percentage (%), and the DS values (%) were submitted to Kolmogorov–Smirnov test, two-way ANOVA (material × disinfectant), and Tukey's test ($\alpha = 0.05$). **Results:** All elastomeric impression materials showed 100% of detail reproduction, regardless of the disinfection procedure. Polysulfide (not disinfected) and polysulfide and polydimethylsiloxane (after disinfection with 0.2% chloramine-T) showed the smaller mean values of DS. **Conclusion:** According to the stability properties analyzed, chloramine-T can be used for disinfection of elastomer molds.

Key words: Detail reproduction, dimensional stability, disinfectant solution, elastomeric impression materials

INTRODUCTION

Impression materials are used for rehabilitation treatments using fixed and removable prosthesis and in the preparation of study models in several other areas.[1] The first elastomeric impression materials are rubbery materials that allow easier techniques for the clinician, do not require the use of special equipment such as those used for reversible hydrocolloids, and have reduced working time, having, therefore, achieved unparalleled popularity in the dental environment. Currently, polysulfide, polyether,

Access this article online
Quick Response Code:
Website: www.eurjdent.com

How to cite this article: Guiraldo RD, Berger SB, Punhagui MF, Moretto TS, Lopes MB, Gonini-Júnior A, *et al*. Influence of chloramine-T disinfection on elastomeric impression stability. Eur J Dent 2018;12:232-6.

DOI: 10.4103/ejd.ejd_195_17

polydimethylsiloxane, and polyvinyl siloxane are used as elastomeric impression materials, each of them bearing particular chemical reactions and setting characteristics.[2]

Several decades have passed since dental impression disinfection has been integrated in modern dentistry as a way of preventing cross-infection with the dental team.[3-5] Dentists and supporting dental personnel are exposed to a variety of microorganisms that may lead to infectious diseases, such as acquired immunodeficiency syndrome, hepatitis B, tuberculosis, and herpes I and II.[6] Transmission of these diseases occurs due to contact with blood and other body fluids, while performing dental procedures and handling contaminated instruments and impressions.[7,8] Various studies have shown that handling contaminated dental impressions, as well as the stone casts poured from them, can lead to infections.[4,9,10] To avoid this, the disinfection and sterilization of dental instruments and materials, including impressions, are recommended by the American Dental Association (ADA). Many studies[2,11,12] have examined the stability of elastomer, but fewer studies have been conducted with different elastomeric impression materials disinfected by chloramine-T.[13] Thus, the objective of this study was to evaluate, according with the ISO 4823,[14] the stability of elastomer through detail reproduction and dimensional stability (DS) after disinfection with 0.2% chloramine-T.

MATERIALS AND METHODS

The elastomeric impression dental materials used in this study were polydimethylsiloxane (Oranwash L; Zhermack, Badia Polesine, RO, Italy), polyvinyl siloxane (Express; 3M Deutschland GmbH, Seefeld, Germany), polysulfide (Permlastic; Kerr, Romulus, MI, USA), and polyether (Impregum Soft; 3M Deutschland GmbH).

The entire press procedure was performed on a matrix [Figure 1] in accordance with the ISO 4823,[14] and the detail reproduction and DS were evaluated on the 20-µm line. Standardized trays were used to perform the impressions. The elastomers were handled following all the manufacturer's instructions (environment with temperature – 23°C ± 2°C and relative humidity – 50% ±10% controlled) and placed over the entire inner part of a tray which was later seated on a matrix metal. After the elastomer polymerization, the impressions were removed from the metal matrix and disinfected or nondisinfected; thus, eight groups (n = 5) were established. The disinfection process was performed by immersion of 15 min in 0.2% chloramine (Trihydral; Perland Pharmacos Ltda, Cornélio Procópio, PR, Brazil).

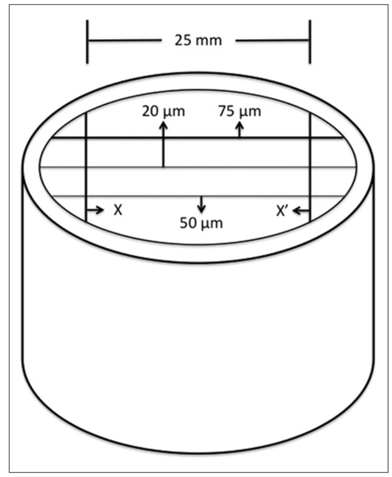

Figure 1: Schematic representation of matrix in accordance with ISO 4823

In accordance with the ISO 4823,[14] detail reproduction of impressions was analyzed using an optical microscope (Stereozoom Microscope, Bel Engineering Srl, Monza, Italy) over the 20-µm line with 25 mm of length at a magnification of ×4, and the detail reproduction values were subsequently subjected to descriptive analysis by percentage (%).

DS was measured using an optical microscope (Scanning Tunneling Microscope, Olympus Optical Co Ltd, Japan) with an 0.5 µm accuracy by subtracting the distance between the lines X and X' over the 20-µm line on the matrix (DM) from the distance between the lines on the impression material (DI) divided by DM and multiplied by 100 establishing the equation: $DS = [(DI - DM)/DM] \times 100$, in accordance with the ISO 4823.[14] Then, 100% was added to the results of the equation,[15] and the DS values (%) were submitted to Kolmogorov–Smirnov test, two-way ANOVA (material × disinfectant), and Tukey's test ($\alpha = 0.05$).

RESULTS

All elastomeric impression materials showed 100% of detail reproduction regardless of the disinfection procedure [Table 1].

A statistically significant difference was found in the mean values of DS, regarding the disinfectant procedure and elastomeric impression material

Table 1: Mean values of stability (%) for different properties

Elastomeric impression	Detail reproduction (%)		Dimensional stability (%)	
	No disinfectant	0.2% chloramine T	No disinfectant	0.2% chloramine T
Express (polyvinyl siloxane)	100	100	99.93 (0.02)^{A,a}	99.91 (0.04)^{A,B,a}
Impregum soft (polyether)	100	100	99.93 (0.03)^{A,a}	99.96 (0.04)^{A,a}
Oranwash L (polydimethylsiloxane)	100	100	99.81 (0.05)^{B,a}	99.75 (0.06)^{C,a}
Permlastic (polysulfide)	100	100	99.69 (0.06)^{C,b}	99.83 (0.83)^{B,C,a}

Mean values followed by different lowercase letters in rows and uppercase letters in columns differed statistically by Tukey's test at 5% level of significance. SDs are provided in parentheses. SDs: Standard deviations

interaction ($P = 0.003$). Polysulfide (not disinfected) and polysulfide and polydimethylsiloxane (after disinfection with 0.2% chloramine-T) showed the smaller mean values of DS [Table 1].

DISCUSSION

Transmission of pathogenic microorganisms is an important issue for dental health-care workers;[16,17] for this reason, there is a need for disinfection. Disinfection is the process that eliminates microorganisms in vegetative form, except from bacterial spores. This process should only be indicated in the impossibility of subjecting the material to the sterilization process. The disinfection of impressions before being sent to the dental laboratories is of paramount importance, as the transfer of microorganisms to the models in gypsum originated from contaminated molds has been demonstrated. In general, the impressions are rinsed in running water to remove saliva or blood. However, according to the ADA, even though washing removes a part of the microbial flora, pathogenic microorganisms may remain on the surface of the molds.[3] The standards of the ADA suggest that materials such as irreversible hydrocolloids, polysulfides, polyesters, polyvinyl siloxane, and polydimethylsiloxane should be washed in running water and immersed or sprayed in disinfectant solution. The decontamination of molding materials is essential for the control of cross-infection.[18] Moreover, in addition to successful disinfection, the physicochemical properties of the molding material, such as reproducibility, DS, and degree of wetting, are required.

It is advised that elastomeric impression materials be disinfected by immersion in glutaraldehyde[7,11] or sodium hypochlorite.[7] Glutaraldehyde is considered to be a powerful disinfectant[19] capable of eliminating some spores, the bacillus responsible for tuberculosis, vegetative bacteria, fungi, and viruses.[20] Nevertheless, its use has been banned from some Brazilian states.[20] On the other hand, substances containing chlorine are regarded as less powerful disinfectants. It is the case of 2% sodium hypochlorite that has little effect on bacterial spores and viruses without lipids but is effective against tuberculosis bacilli, vegetative bacteria, and most fungi.[20] Such disinfectants, however, show disadvantages, such as toxicity during manipulation, leading to eye and respiratory system irritation, environmental damage, and incompatibility with certain sorts of materials, namely metals. Alternatively, another substance that releases chlorine is chloramine-T. Chloramine-T is more stable than hypochlorite in the presence of organic matter and releases chlorine slowly. Chloramine-T acts by biocidal action through oxidative reaction and protein hydrolysis, reacting with the organic material of living microorganisms of any kind, penetrating and/or breaking the cell walls of bacteria: Gram positive, Gram negative, fungi, viruses, microbacteria, yeasts, with which it comes into contact, destroying cellular material or interrupting essential processes, leading to their inevitable destruction. These oxidative and protein hydrolysis reactions kill the microorganisms in both aerobic and anaerobic environments very quickly, even at low concentrations. In the present study, the disinfection agent used was 0.2% chloramine-T.

Depending on the composition of elastomeric materials, significant discrepancies can be found in their rheological properties, interaction, and tolerance of moist surfaces.[15,21-23] Polysulfides and polyethers are hydrophilic as they bear functional groups that attract and chemically interact with water molecules through hydrogen.[21] The hydrophilic nature of polyether groups is represented through the carbonyl (C==O) and ether (COC) groups, while the polysulfide one is disulfide (−SS−) and mercapto (−SH) groups.[21] Nonetheless, the results proved that the 20-µm line was totally reproduced by all elastomeric materials, in this study.

An ideal impression material would be dimensionally accurate over time, therefore being poured at the operator's convenience.[24] The ideal DS is presented by polyvinyl siloxane,[24] while polyether presented the best dimensional accuracy in comparison to polydimethylsiloxane and polysulfide.[25] In another study,[26] this polyether material demonstrated a behavior between the polydimethylsiloxane and polyvinyl siloxane. Therefore, apart from different methodologies, the studies suggest by analogy that polyvinyl siloxane has better dimensional accuracy, followed by polyether. In the present study, polydimethylsiloxane and polysulfide presented less accurate results of DS results for both disinfected impressions and nondisinfected impressions [Table 1]. This probably occurred as a result of contraction due to reduced space during the condensation polymerization reaction, present as its by-product. Dimensional accuracy from 0.1% to 0.8% is compensated in the preparation of restorations at some stages during the laboratory steps.[27] According to Suprono *et al.*,[28] the changes of impressions produced by certain disinfectants were compensated by the setting expansion of different stones. Thus, the dimensional variations found in the present study do not impair prosthetic restorations accuracy significantly.

In a clinic, a dental surgeon faces the possibility of destroyed dental elements. According to the level of the destruction of such teeth, professionals have the option to recommend direct or indirect restorations.[12] One of the most important steps in the indirect metallic or nonmetallic restoration is obtaining an accurate impression of the tooth to be restored and its adjacent tissues, in attempt to reproduce the correct relationship among all of the structures in the buccal cavity.[12] Thus, the success of some forms of dental treatment depends upon the accuracy with which a restoration can be manufactured in the laboratory, using models constructed from impressions.[23] Clearly, the precision of the initial impression both in terms of dimensional accuracy and detail reproduction is a prerequisite for success.[23] The result of the present study shows that clinically, the alteration promoted by chloramine-T disinfection will not affect the final result of the indirect restorations performed from the disinfected impressions. Therefore, due to its extreme importance, disinfection must be performed even though there is a variety of results in the literature.[11] According to the stability properties analyzed, chloramine-T should be used for disinfection of elastomer impressions. However, its effectiveness in disinfection of elastomeric impression materials can only be proved by further studies.

CONCLUSION

Based on the materials used, methodology employed, and results analyzed and discussed, the following conclusions can be drawn:

1. Elastomeric impression materials submitted to chloramine-T disinfection do not affect detail reproduction property
2. Polydimethylsiloxane and polysulfide lead to less accuracy of DS for both disinfected impressions and nondisinfected impressions.

Acknowledgments

We thank Engineer Marcos Blanco Cangiani (Faculdade de Odontologia de Piracicaba) for assisting with the making of the matrix.

Financial support and sponsorship

This study was supported by Fundação Nacional de Desenvolvimento do Ensino Superior Particular. The study sponsor had no involvement in any part of the study.

Conflicts of interest

There are no conflicts of interest.

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