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Accuracy of Impression Material During COVID-19 after Sterilization- *In vitro* Study

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Aims: The goal of this research is to assess the effect of steam autoclave sterilization due to the impact of Covid-19 on the accuracy of the elastomer impression materials.
Study Design: *In vitro* study.
Place and Duration of Study: Department of oral and Maxillofacial Prosthodontics, King Abdul-Aziz University, Jeddah; *Saudi Arabia,* between June 2021 and November 2021.
Methodology: The following materials were used in this study: fully dentate master cast, metal trays, elastomer impression material (addition silicon), type IV stone. Forte impressions made using the metal tray and elastomer impression materials. The impressions were separated equally into two groups: Control group (C.G), untreated impressions. Sterilized group (S.G): Impressions were sterilized by using the steam autoclave. To make stone castings for each group, they were poured with type IV stone. The traveling microscope was used to evaluate the impression material's dimensional accuracy and detail reproduction with and without autoclave sterilization.
Results: The cross-arch distance (X) of the master model was measured (41.29 mm), While the cross arch distance (X) in the control group (C.G) of the untreated impressions had a mean and standard deviation of 41.492 ± 0.150 mm. In the tested group (S.G) : the sterilized impression, we

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found the cross-arch distance (X) had a mean and standard deviation of 41.628 ± 0.223 mm. The master model's Anteroposterior distance (A-P) was measured (21.12 mm). For the control group (C.G) : we found the mean and standard deviation value reading of the A-P distance were 20.899 ± 0.79 mm. For (S.G) group: we found the mean and standard deviation reading of the A-P distance were 19.992± 0.482 mm.

Conclusion: Steam autoclave sterilization of the elastomer impression material should be considered carefully, especially when fabricating fixed partial dentures. If the impression material is to be used in making diagnostic castings, conventional steam autoclave sterilization of the elastomers impression material may be sufficient for patients.

Keywords: COVID-19; dimensional stability; autoclave sterilization; dental biomaterial.

1. INTRODUCTION

At the end of 2019, a new human coronavirus (SARSCoV2) causing severe acute respiratory syndrome, coronavirus disease 2019 (COVID19), was discovered in Wuhan, China [1]. Dental healthcare seems to have a number of clinical, psychological, and financial repercussions as a result of its implications, including unintended effects for dental practitioners, patients, and lab staff [2]. Several saliva- and blood-contaminating particles, which can act as a significant source of virus infection, are deal by prosthodontists [3]. Prosthodontics commonly considered as a therapy that may be postponed; however, there may be certain exceptions, such as replacing a preexisting broken fixed bridge, covering an endodontically treated tooth with a crown or inlay/onlay, fabricating a post and core, or constructing tooth or implant supported prostheses in the esthetic sector. As a result, a dental impression may be required during the COVID19 pandemic [4]. Cross-contamination between dental clinics and labs has been confirmed, published particular infection control guidelines for both laboratories and dental clinics [5]. In this situation, the usual recommendation is to disinfect all departing products, including packing and boxes, before shipping them to the lab and after receiving them from the laboratory [6]. Making an impression is the most important stage in achieving a properly fitted final prosthesis [7]. As a result, it is critical to consider the sides that may be elaborated in the fabrication of prosthesis, one of which is elastomeric impression material [8]. The impression materials used to replicate the shape of the teeth and surrounding structures [9]. This delivers a transmission of highly infectious pathogens such as hepatitis B and C among others [10].

As a standard regulation of infection control guidance all impressions required to be disinfected before delivery to the lab [11]. Azevedo et al. [12] A study was undertaken by Al Kheraif et al. [13] to assess the influence of chemical disinfection and the autoclave, showing the clinical importance of this study: Even though chemical sterilization does not remove all the pathogens. The steam autoclave of elastomeric impression materials could be contemplated an effectual system over the chemical system. Dimensional stability was the subject of study in 2015. After autoclave sterilization, the results showed that half of the forte samples were assigned to the tested group that autoclaved for 5 minutes at 134°C. twenty samples were used as a control group. The measurements variation were determined after one hour and after twenty-four hours for two-time intervals [14].

The goal of this research is to assess the effect of steam autoclave sterilization due to the impact of Covid-19 on the accuracy of the elastomer impression materials.

2. MATERIALS AND METHODS

The materials enclosed in this research: Elastomer impression material (addition silicon, Aquasail Ultra, mono phase, Dentsply), metal trays, type IV stone and steam autoclave machine (EN 13060 OT 23B, Nűve SteamArt).

A master cast of type IV stone was made from a duplicated fully dentate upper arch model (Kavo, Basic Study Model) using Z-Dupe Duplicating Silicon Set (Henry Schein Inc. - D4801HSI). Then a reference point marked in the master cast as following; the mid surface of the palatal side of the right and left first molars as a cross sectional measurement (X), and on the palatal side of the upper arch central incisor as an anteroposterior reference measurement (A-P). The reference points were measured 41.29 mm and 21.12 mm correspondingly.

Forte impressions were made using elastomer impression material addition silicon (Aquasil Ultra monophase, Regular set by Dentsply).

2.1 The Impressions were Separated into Two Groups:

C.G group: (n= Twenty) unsterilized impressions.
S.G group: (n=Twenty) sterilized impressions by the steam autoclave.

2.2 Treatment of the Impressions

Control group (C.G)

The impressions were not treat in any way and were poured according to the manufacturer's instructions.

Sterilization group (S.G)

The impressions were placed in sterilization bags at the steam autoclave (EN 13060 OT 23B, Nűve SteamArt) using the preset prion program that run for 20 minutes at 134°C. The impressions were taken from the sterilizing bag after autoclaving and left over in room temperature for 24hrs before being poured.

2.3 Pouring the Impressions

All impressions (control and steam autoclave sterilized) were poured with type IV stone 24 hours after they were set according to the manufacturer's instructions. As indicated by the makers, a 20 ml water to 100-gram type IV stone powder ratio was utilized. Initially hand mix started followed by the vacuumed mixer for 15 seconds, each impression poured using the vibrator to eliminate voids. After 40 minutes, each group's poured impressions were inverted over a rubber base former filled with the same stone. Allow one hour to set according to the manufacturer's instructions.

2.4 Measuring the Cast Dimensions

The impressions' dimensional stability and detail reproduction were assessed indirectly by measuring several relevant reference points on the stone cast recovered from the impression of each group as following; [Fig. 1].

- Distance (X): Cross arch distance: from the mid surface of the palatal side of upper arch first right molar to the mid surface of the palatal side of upper arch first left molar.
- Distance (A-P): Anteroposterior distance from the mid surface of the palatal side of the upper arch first left molar to the center of the palatal side of central incisors.

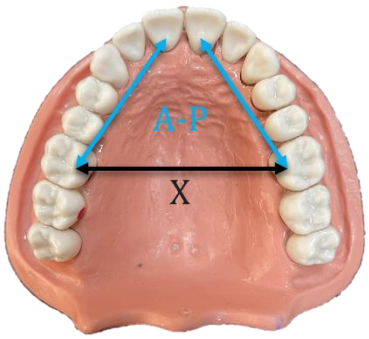

Fig. 1. The reference point cross-arch distance (X) and the anteroposterior distance (A-P)

The distances on each group were measured using a traveling microscope, and the results were compared to those of the master model and the control group.

Each value was averaged after three measurements of each dimension. One examiner was in charge of all measures.

3. RESULTS AND DISCUSSION

An independent two-sample t-test results to compare between groups was used. Dimensional alterations are shown by the differences between the master model and the tested models' dimensions (X, A-P) of each group. Non-normal distribution has been shown by dimensional alterations. SPSS Statistics software 23.0 for Windows was used for statistical analysis.

Effect of sterilization on the exactitude of the variable measurements:

Cross arch distance (X): The cross-arch distance of the master model (X) was measured (41.29 mm).

C.G group: (n= Twenty) Untreated impressions in a control group. The cross-arch distance (X) in C.G. casts had a mean and standard deviation of 41.492 ± 0.15 mm.

S.G group: (n= Twenty) The steamed autoclave was used to sterilize the impressions. The cross-arch distance (X) in S.G casts had a mean and standard deviation of 41.628 ± 0.223 mm.

Table 1. The mean and the standard deviation (SD) value and results of independent two-sample t-test for comparison between cross arch measurement (X) of master model and stone models

C.G		S.G		Master model	*P*-value
Mean	**SD**	**Mean**	**SD**		
41.492	0.15	41.628	0.223	41.29	0.03*****

**: reject the null hypothesis if the P < the alpha value 0.05*

Table 2. The mean and the standard deviation (SD) value and results of independent two-sample t-test for comparison between Anteroposterior measurement (A-P) of master model and stone models

C.G		S.G		Master model	*P*-value
Mean	**SD**	**Mean**	**SD**		
20.889	0.79	19.992	0.482	21.12	0.0001*

**: reject the null hypothesis if the P < the alpha value 0.05*

There was no statistical significance difference between C.G. and S.G. [Table 1]

The dimensional variations and proportion in the (X) measurement of the various samples were measured:

The M (mean) of SD standards of (X) dimension in C.G were 0.170 ± 0.191. While we found it in S.G 0.242 ± 0.365. This was followed by C.G the proportion of measurement variation of controlled group 0.45% and the sterilized group 0.86%.

Anteroposterior measurement (A-P): The master models was measured (21.12 mm).

C.G group: (n=10) Control group, untreated impressions. The M (mean) and SD standards of A-P measurement (A-P) in stone casts established from controlled casts were 20.889 ± 0.79 mm.

S.G group: (n= Twenty) Impressions were sterilized by the autoclave (S.G): The M (mean) and SD standard of A-P measurement (A-P) in stone casts achieved from S.G were 19.992 ± 0.482 mm.

There was no statistic significant variation between the steam sterilized samples and the untreated samples (P-value = 0.0001). [Table 2]

The dimensional changes and the proportion in the anteroposterior measurement of the various samples were measured:

The M (mean) and SD standard of Antero posterior distance changes in the casts of untreated samples were 0.619 ± 0.770 mm and 1.758 ± 0.412 mm achieved steam sterilized samples.

4. DISCUSSION

COVID-19 (novel coronavirus) is a new and emerging serious infection that is quickly spreading over the world. Clinical signs and symptoms vary from non-specific respiratory symptoms like fever and cough to shortness of breath, pneumonia symptoms, and severe acute respiratory infection. However, the number of reported instances has increased dramatically over time [1].

Transmission of infection between the clinic and dental laboratory is frequently caused by saliva and blood contaminated impressions. The practitioner and the dental technician in lab, must communicate clearly and follow an infection control guidance while handling dental impressions [15,16]. Infection control protocols, for example, could contain rules for correct impression handling and disinfection or sterilization. Sterilization is best accomplished using a steam autoclave sterilization, which takes shorter period and is more dependable than chemical disinfection. Though disinfecting impressions is common practice, steaming sterilization the elastomer impression materials is an efficient means of sterilization [17].

The elastomer addition silicon impression material used in this research (Aquasail Ultra, Mono phase, Dentsply) has the most exceptional properties. Because no by-products are produced during the polymerization operation, this imprint material is dimensionally stable [18]. The additional silicon material used in this study was supplied by the manufacturer in an auto-mix system, which is convenient and provides a constant mix while including the fewest bubbles into the mix [19].

In the C.G group, the impressions were molded with no disinfection protocol whereas the impression of the S.G group, were steamed autoclave sterilized for 20 minutes at 134°C to mimic the Holtan J. et al 1991, that concluded 15 minutes autoclaved sterilization at 134°C were sufficient to disinfect the impression [20].

The assumption of this research was that there were no changes in the exactitude of the molds made from the sterilized and the controlled impression. This assumption was accepted as autoclaved samples showed inconsiderable variation in impressions whereas untreated controlled models showed no differences, in both the (X) and (A-P) measurements. The enhanced stone castings created in the sterilizing group were larger than the master model [16,21]. The untreated castings were more accurate in the anteroposterior dimension than the sterilized enhanced stone casts. It was also larger than the master model for the cross-arch dimensions alteration of the sterilized enhanced stone castings.

This research disagreed with the findings of those Olin et al. [22] and Holton JR, et al. [20], who found that steam autoclave sterilization caused greater dimensional changes in polyvinyl siloxane impression material. They suggested that the warpage of the plastic tray caused by high temperatures during sterilization may be the origin of the deformation shown in the castings generated for the steam-treated group of impressions.

The findings of this study were in line with Surendra G. P. et al who stated that; immediately after autoclaving, there was a no statistically significant increase in dimensional changes (Affinis, impression material), followed by a non-statistically significant decrease in dimensional changes after 24 hours. They suggested delaying the pouring of an autoclavable elastomeric impression material by around one day [23].

5. CONCLUSION

Enclosed to the restraint of this study; Steam autoclave sterilization of the elastomer impression material should be considered carefully, especially when fabricating fixed partial dentures. If the impression material is to be used in making diagnostic castings, conventional steam autoclave sterilization of the elastomer's impression material may be sufficient for patients.

Further study in this topic considers a good point of research.

CONSENT

It is not applicable.

ETHICAL APPROVAL

Institutional research ethics board approval was acquired before conducting any study-related procedures. Ethical approval was obtained from Research Ethics Committee King Abdul-Aziz University with the IRB approval number (302-10-21).

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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