



The Effects of Chemical Disinfection on Dimensional Stability among Different Type of Impression Addition Silicon Materials

Salah A. Yousief ^{*1,2}, Khames T. Alzahrani ³, Suha M. Alhuwairini ⁴, Fai Y. Alharbi ⁴, Dalal A. Eissa ⁴, Sara M. Almojaddidi ⁴, Maha A. Almalki ⁴, Waad E. Alsulami ⁴, Waad K. Alsaiari ⁴, Abdullah J. Algharamah ⁴, Bashayir G. Althagafi ⁴, Mamoun M. Abo Khalil ⁵

¹Department of Restorative and Prosthetic Dental Sciences, College of Dentistry, Dar Al Uloom University, Riyadh

²Crown & Bridge Department, Faculty of Oral and Dental Medicine, Al Azhar University, Assuit Branch, Egypt

³Department of Restorative Dentistry, BDS, PGD Endo, Ministry of Health, Saudi Arabia

⁴Department of Fixed Prosthodontic, BDS, Kingdom of Saudi Arabia

⁵Department of Fixed Prosthodontic, Lecturer at Alfarabi College, Jeddah, Saudi Arabia

Correspondence addressed Salah A. Yousief; salah.a@dau.edu.sa

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Abstract

Introduction: Saliva and blood contaminated impressions are often a source of cross contamination between the clinic and dental laboratory. Explicit communication and observance of an infection control protocol for handling of dental impressions must exist among the office staff as well as between office and dental laboratories. Though disinfection of impression is routinely followed, autoclaving elastomeric impression is an effective method of sterilization them. **Objectives:** The purpose of this study was to evaluate dimensional stability and detail reproduction of a new addition silicon impression material after disinfection. **Methods:** In this study, a total of twenty impressions for the master model using heat resistant plastic stock trays. The twenty impressions were divided into two groups according to disinfection technique: (Table 2) Group 1: (n=10) Control group, untreated impressions. (C.G) Group 2: (n=10) Impressions were chemically disinfected. (D.G). after all impressions treatment, they were poured with extra hard stone (type IV) to get stone casts. Dimensional accuracy and detail reproduction of the impression material were evaluated indirectly through the recovered improved stone casts from impressions of the master model using the travelling microscope. **Results:** Cross arch distance (A): Epoxy resin master model cross arch distance measurement (A) was (41.36 mm). 1.1 Measurements of the cross-arch distance of stone casts_Control group (C.G): The mean and standard deviation values of distance (A) in stone models obtained from C.G. were 41.553 ± 0.170 mm. Disinfection group (D.G): The mean and standard deviation values of distance (A) in stone models obtained from D.G were 41.368 ± 0.083 mm. ANOVA test showed that there was a statistically difference shrinkage between the groups (P-value = 0.006). 1.2 Measurement of the dimensional changes in the cross-arch distance of the different groups. The mean and standard deviation values of cross arch distance changes in stone models of C.G. were 0.191 ± 0.170 mm. while dimensional changes in stone models obtained from D.G. were 0.006 ± 0.082 mm. **Conclusion:** The purpose of this study was to evaluate dimensional stability and detail reproduction of a new addition silicon impression material after disinfection. In this study an epoxy resin master model was duplicated from a modified dentate mandibular model. Within the limitations of this study, it could be concluded that Chemical disinfectant of polyvinyl siloxane impression material can be successfully used in making fixed partial dentures.

Keywords: *impression, Chemically Disinfected, Infection Control.*

Introduction

Impression making is the one and most important step to achieve an accurately fitting final restoration. Therefore, it is essential to understand the factors that may be involved in the process of fabricating indirect restorations, elastomeric impression material is being one of them. Impression materials are used to register or

reproduce the form and relation of teeth and the surrounding oral tissues ^[1]. The most biologically contaminated item to leave the dental clinic for further handling is the dental impression on its way to the dental laboratory. Dental impressions become contaminated with the patient's saliva, bacterial plaques, and blood. This offers a significant cross-infection vehicle for dangerous pathogens such as the human immunodeficiency virus and

hepatitis-B and C virus among others [2]. It is now a requirement of standard cross-infection protocols that impressions should be delivered to the laboratory after disinfection [3]. A wide range of disinfectants has been advocated and of these, sodium hypochlorite, sodium metabisulphite, and glutaraldehyde are probably the most popular. Other experimental techniques are ultraviolet radiation and microwave radiation for impression disinfection [4]. None of these solutions have become a universally accepted standard. The disinfection process aims to eliminate microorganisms from the surface of the impression. However, an undesirable side-effect of the disinfection process is the potential for a change in the dimensions of the impression that may be associated with a chemical or physico-chemical interaction between the set material and the disinfecting solution [5].

To avoid contamination of dental office staff and dental technicians, it has been recommended that impressions must be disinfected immediately after their removal from the mouth. Unfortunately, not all impression materials can be disinfected without adversely affecting their properties and hence, recommended methods differ depending on the type of the impression material [6].

Problems in disinfecting impressions by traditional methods have led to the introduction of a new auto-clavable impression material as an alternative. However, the effect of impression material sterilization on its dimensional accuracy and details reproduction needs further investigations [7]. The impression is a crucial part of the process of constructing a well-fitting prosthesis; it is imperative that it copies the exact topography of the recorded site and translates it accurately to its cast. To achieve this, the impression material must be both accurate and stable [8]. There are four types of elastomeric impression materials available for crown and fixed partial denture fabrication: addition silicone, condensation silicone, polysulfide, and polyether. Accuracy and dimensional stability are two principal characteristics of the impression material [9]. The accuracy of an impression material is dependent on the dimensional stability, which is the ability of an impression material to maintain the accuracy of the impression over the time. Practically, an impression from a material with high dimensional stability can be poured several weeks later and still produce an accurate model [10]. The distortion of the material during the retrieval of stone cast, also, influence the dimensional accuracy of the subsequent casts [11,5]. ADA specification number 19 recommended a maximum negative change (shrinkage) in dimension to be 0.50% after a minimum of 24 hours [12]. While in other studies the accuracy of the impression material was assessed indirectly by measuring seven dimensions on stone casts poured from impressions of a stainless-steel master model [13]. Clinically, several impression material investigations have concentrated on replication in the presence of crevicular moisture [14].

Saliva and blood contaminated impressions are often a source of cross contamination between the clinic and dental laboratory [15]. Explicit communication and observance of an infection control protocol for handling of dental impressions must exist among the office staff as well as between office and dental laboratories [6]. Though disinfection of impression is routinely followed, autoclaving elastomeric impression is an effective method of sterilization them improved [16]. The purpose of this study was to evaluate dimensional stability and detail reproduction of a new addition silicon impression material after disinfection and sterilization.

Materials and Methods

Materials

In the present study the following materials were used (Table 1):

- 1) Polyvinyl siloxane impression material (heavy and light body) *
- 2) Heat resistant plastic trays**
- 3) Die stone material (extra hard stone, type IV) ***
- 4) Chemical disinfectant solution (Glutaraldehyde 2%) ****

Table 1: Materials used in this study

Material	Composition and description	Manufacture
1- Polyvinylsiloxane impression material (Heavy body)	Polyvinyl siloxane Methyl hydrogen siloxane Organo-platinic complex Silica Additives Automix cartridge Color: Orange	Coltene wholedent Switzerland

* Affinis, impression material, Coltene, Switzerland.

** Affinis, heat resistant plastic tray, Coltene, Switzerland.

*** ZETA, type IV Gypsum product, Italy.

**** Elnasr pharmaceutical company, Egypt.

Material	Composition and description	Manufacture
2- polyvinylsiloxane impression material (light body)	Poly vinyl siloxane Methyl hydrogen siloxane Silica Food dyes Additives Automix cartridge Color: Light green	Coltene wholedent Switzerland

In this study an epoxy resin master model was duplicated from a modified dentate mandibular model, which consisted of a dentate mandibular arch with modifications. Three copper cylindrical ring inserts, one on each occlusal surface of the right and left first molars and one on the lingual surfaces of the mandibular incisors provided reference points for measuring cross-arch dimension (41.36mm), and anteroposterior dimension (21.06 mm). In addition, the master model contained stainless steel die for full metal crown preparation in the position of the mandibular right premolars area. The stainless-steel die was machined with 6-degree angle of convergence, and (4.23mm) occluso-gingival height with (0.5 mm) gingival chamfer finish line. Heat resistant addition silicon impression material was used for making 20 impressions for the master model using heat resistant plastic stock trays.

In this study, a total of twenty impressions for the master model using heat resistant plastic stock trays. The twenty impressions were divided into two groups according to disinfection technique: Group 1: (n=10) Control group, untreated impressions. (C.G) Group 2: (n=10) Impressions were chemically disinfected. (D.G).

After all impressions treatment, they were poured with extra hard stone (type IV) to get stone casts. Dimensional accuracy and detail reproduction of the impression material were evaluated indirectly through the recovered improved stone casts from impressions of the master model using the travelling microscope.

Master model fabrication: An epoxy resin master model was fabricated in this study by duplication of a dentate mandibular model*

Drilling of Holes: Holes were drilled on the occlusal surface of both first right and left molars (3mm width x 6mm depth). The third hole was drilled on the lingual surfaces of the central incisors (3mm width x 4mm depth). The holes were drilled by a special drilling machine**. Another hole was created on the mandibular right premolar area (6mm width x 8mm depth).

Fabrication of copper cylindrical rings: Copper cylindrical ring with the same dimensions of each hole (3 mm width x 6 mm depth) were fabricated from a copper bar using a special milling machine. Cross lines were created on the top part of each copper cylinder to act as reference marks during measuring of the dimensions.

Results

Statistical analysis

Data were presented as mean and standard deviation (SD) values. One-way ANOVA was used to compare between measurements of the two groups and the master model. Tukey's post-hoc test was used for pair-wise comparisons between the groups when ANOVA test was significant. Posterior distance, occluso-gingival height and finish line thickness) and stone model measurements represent the dimensional changes. Dimensional changes showed non-parametric (non-normal) distribution. So, Kruskal-Wallis test was used to compare between the three groups. This test is the non-parametric alternative to one-way ANOVA. Mann-Whitney U test was used for pair-wise comparisons between the groups when Kruskal-Wallis test was significant. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with PASW Statistics 18.0 © (Predictive Analytics Software) for Windows.

Effect of Disinfection techniques on accuracy of different measurements:

1. Cross arch distance (A):

Epoxy resin master model cross arch distance measurement (A) was (41.36 mm).

1.1 Measurements of the cross-arch distance of stone casts

Control group (C.G): The mean and standard deviation values of distance (A) in stone models obtained from C.G. were 41.553 ± 0.170 mm.

Disinfection group (D.G): The mean and standard deviation values of distance (A) in stone models obtained from D.G were 41.368 ± 0.083 mm. ANOVA test showed that there was a statistically difference shrinkage between the groups (P -value = 0.006).

1.2 Measurement of the dimensional changes in the cross-arch distance of the different groups. The mean and standard deviation values of cross arch distance changes in stone models of C.G. were 0.191 ± 0.170 mm. while dimensional changes in stone models obtained from D.G. were 0.006 ± 0.082 mm.

1.3 Percentage (%) of the dimensional changes in the cross-arch distance of the different groups

The Percentage of dimensional changes of C.G. was 0.46%, while that of D.G. was 0.01%.

2. Anteroposterior distance (B):

Measurement of the anteroposterior distance of the master model was (21.06 mm).

2.1 Measurements of the anteroposterior distance of stone casts of different groups were presented in: (Table 5, Figure 19) Control group(C.G): The mean and standard deviation values of A-P distance (B) in stone models obtained from C.G. were 20.981 ± 0.770 mm. Disinfection group(D.G): The mean and standard deviation values of A-P distance (B) in stone models obtained from D.G. were 21.052 ± 1.194 mm.

2.2 Measurement of the dimensional changes in the anteroposterior distance of different groups

3. Finish line Thickness:

The finish line thickness of the stainless-steel die in the epoxy master model was (0.5 mm).

3.1 Measurements of the Finish line Thickness of stone casts of different groups.

Control group (C.G): The mean and standard deviation values of finish line thickness in stone models obtained from C.G. were 0.552 ± 0.056 mm. Disinfection group (D.G): The mean and standard deviation values of finish line thickness in stone models obtained from D.G. were 0.573 ± 0.035 mm.

3.2 Measurement of the dimensional changes in the finish line thickness of the different groups the mean and standard deviation values of finish line thickness changes in stone models of C.G. were 0.052 ± 0.038 mm. While dimensional changes in stone models obtained from D.G. were 0.073 ± 0.030 mm.

3.3 Percentage (%) of the dimensional changes in the finish line thickness of the different groups The Percentage of dimensional changes of C.G. was 9.4%, while that of D.G. was 12.7%.

4. Occluso-gingival height:

The occluso-gingival height of the stainless-steel die in the epoxy resin master model was (4.23 mm).

4.1 Measurements of the stone casts of different groups.

Control group (C.G): The mean and standard deviation values of occluso-gingival height of the die in improved stone models obtained from C.G. were 4.392 ± 0.117 mm. Disinfection group (D.G): The mean and standard deviation values of occluso-gingival height of the die in stone models obtained from D.G. were 4.345 ± 0.114 mm.

4.1 Measurement of the dimensional changes in the occluso-gingival height of the different groups the mean and standard deviation values of height changes in stone models of C.G. were 0.154 ± 0.117 mm. While dimensional changes in stone models obtained from D.G. were 0.107 ± 0.114 mm. Kruskal-Wallis test showed that there was no statistically significant difference between the groups (P -value = 0.330).

4.2 Percentage (%) of the dimensional changes in the occluso-gingival height of the different groups The Percentage of dimensional changes of C.G. was 3.63% while that of D.G. was 2.52%.

Discussion

Saliva and blood contaminated impressions are often a source of cross contamination between the clinic and dental laboratory. Explicit communication and observance of an infection control protocol for handling of dental impressions must exist among the office staff as well as between office and dental laboratories. Such as infection control protocol should include guidelines for proper handling and disinfection or sterilization of impression. As a part

of infection control protocol, it is important to distinguish between sterilization and disinfection, sterilization results in destruction of all spores of microbial life (viruses and fungi) where disinfection results in destruction of pathogenic microorganisms.

The impression material selected in the present study is one of most recent available rubber base impression material (polyvinyl siloxane). Addition silicon impression material had excellent physical properties, it can record fine details and had the best elastic recovery of all available impression materials. This impression material is dimensionally stable as it produces no by-products during polymerization reaction [17].

Also, polyvinyl siloxane have moderate working time, high rigidity when set but with no difficulty in removal or separation of the induced model [17,18]. As the oral environment and its water content nature prefer the impression to be hydrophilic, the use of new generation of the polyvinyl siloxane impression material with their hydrophilic property, could conceivably make impression-making procedures and pouring gypsum casts easier [18]. The direction of dimensional change of impression materials has been reported to be dependent upon the bonding of the material to the impression tray [18]. Also, more rigid trays reduce the possibility of distortion in the impression [3]. Therefore, in our study, a rigid, perforated plastic impression trays were used for all impressions, they have the ability to resist distortion expected during seating and removal of the tray. Whether custom or stock trays are used for impressions, another potential source of error may arise if the material is not adequately retained in the impression tray when it is removed from the mouth. The use of adhesive in the trays has been shown to achieve higher material bond strengths for polyvinyl siloxanes than has mechanical retention [7]. Therefore, tray adhesive was used in this study. The master model in this study was fabricated from epoxy resin as it does not interfere with the removal of the impressions and its ability to hold the reference marks in its place due to the high dimensional accuracy of this type of resin [1]. The control group, impressions were poured without surface treatment while in sterilization group, the impressions were autoclaved for 15 minutes at 134°C in accordance with Holtan J. et al, [9] as they reported that autoclaving of the impression for 15 minutes at 134°C is enough to kill microbial spores. In the disinfection group, the impressions were immersed in (2% glutaraldehyde) solution for 30 minutes as this technique was proved by Herrera and Merchant, [20] to be the most reliable disinfection method because the immersion of the impression ensures that the disinfectant solution comes into contact with all the impression material surfaces and the tray. The disinfectant used was (2% acid glutaraldehyde) for 30 minutes similar to that used in a previous study [21].

The research hypothesis of this study was that no differences existed in accuracy of casts recovered from the impressions for the disinfected and untreated samples. This hypothesis was partially rejected because no differences between the disinfected and untreated samples were observed. In disinfected group, the improved stone casts showed no significant difference in comparison with master model in both anteroposterior and cross arch distances.

The results of the disinfection group presented study disagreed with those of Drenon et al and [22] Setcos et al, [23] who evaluated the effects of different disinfectant solutions and times on two hydrophilic impressions materials. They reported that there was little expanding effect on the dimensional stability of two types of hydrophilic silicon rubber impressions materials. The results of the present study was in agreement with these Del Pilar Rios et al [24] who tested the dimensional stability of different impression

materials following immersion disinfection for thirty minutes. They observed that polyvinyl siloxane and polysulphide were unaffected after immersion in 2% glutaraldehyde.

Regarding the dimensional accuracy including the finish line thickness and the occluso gingival height, the results of the present study showed that there was no statistically significant difference between the two groups; all showed not statistically significantly higher mean thickness than the master model. The results of the presented study was in agreement with those of Adabo et al, [25] who investigated the effect of disinfection methods on the dimensional stability of six elastomeric materials among which was the polyvinyl siloxane. And reported that the disinfecting treatments did not differ from the control. Results of the present study were also in agreement with Johnson G.H. & Criage R.C. [2] where there was no statistically significant difference between casts and dies produced after immersion disinfection and the control group.

One limitation of this study lies with differences in making impressions in vivo compared to in vitro. For example, the use of plastic teeth and tissues could affect distortion by their adherence to the impression material. Also, no moisture equivalent to saliva was used, and there was no way to simulate the biofilm that exists on oral surfaces and comes into contact with the impression material. Retraction cord and haemostatic agents are often used when making impressions, and their effects were not assessed. The measuring system used was linear, and so did not account for rotational changes in the shape of the improved stone casts.

Conclusion

The purpose of this study was to evaluate dimensional stability and detail reproduction of a new addition silicon impression material after disinfection. In this study an epoxy resin master model was duplicated from a modified dentate mandibular model. The epoxy resin master model had three copper cylindrical ring inserts, one on each occlusal surface of the right as well as left first molars and one on the lingual surfaces of the mandibular incisors provided reference points for measuring cross-arch dimension (41.36mm) and anteroposterior dimension (21.06 mm). In addition, the master model contained stainless steel die for full metal crown preparation in the position of the mandibular right premolars with 6-degree angle of convergence, (4.23mm) occluso -gingival height with (0.5 mm) gingival chamfer finish line. Travelling microscope was used to measure certain distances on the epoxy resin master model. 1-Distance A: Cross arch distance: from the first right mandibular molar to the first left mandibular molar (41.36 mm). 2-Distance B: Antero posterior distance: from the mandibular first left molar to the lingual surface of central incisors (21.06 mm). 3-Occluso-gingival height of the stainless-steel die (4.23 mm) 4-Finish line thickness of the stainless-steel die (0.5 mm).

Within the limitations of this study, it could be concluded that Chemical disinfectant of polyvinyl siloxane impression material can be successfully used in making fixed partial dentures.

Conflicts of interest

The authors have no conflicts of interest to declare.

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