The Saudi Dental Journal 36 (2024) 603–609

Contents lists available at ScienceDirect

The Saudi Dental Journal

journal homepage: www.ksu.edu.sa
www.sciencedirect.com

Original Article

Comparative analysis of dimensional changes in autoclavable polyvinyl siloxane (PVS) impressions under various Sterilization/Disinfection Protocols: A randomized controlled trial

Noha Taymour [a,*], Sanaa Hussein Abdel Kader [b], Moustafa N. Aboushelib [c], Mohammed M. Gad [a]

[a] Department of Substitutive Dental Sciences, College of Dentistry, Imam Abdulrahman Bin Faisal University, P.O. Box 1982, Dammam 31441, Saudi Arabia
[b] Department of Conservative Dentistry, Faculty of Dentistry, Alexandria University, Alexandria, Egypt
[c] Department of Dental Biomaterials, Faculty of Dentistry, Alexandria University, Alexandria, Egypt

ARTICLE INFO

Keywords:
AFFINIS impressions
Polyvinyl siloxanes impressions
Disinfection
Autoclaving

ABSTRACT

Background: Impressions that maintain their dimensional stability after autoclaving effectively control cross-infection and contamination resulting from a patient's oral secretions.
Purpose: The study aimed to assess the dimensional stability of autoclavable polyvinyl siloxanes after disinfection and sterilization.
Methods: A stainless steel metal model containing three full veneer crown preparations was fabricated according to ANSI/ADA specification No. 19. Reference grooves were established on the occlusal and axial surfaces of the abutments for accurate measurements. Forty impressions were created from the master model using single-step impression technique monophase polyvinyl siloxane material (AFFINIS, Coltene/Whaledent, Altstatten, Switzerland). The impressions were categorized into four groups: Group A (control, ten untreated impressions), Group B (ten disinfected impressions with 5.25 % sodium hypochlorite [NaOCl]), Group C (ten disinfected impressions with 2 % glutaraldehyde), and Group D (ten autoclaved impressions at 134 °C for 18 min). Subsequently, stone casts were produced using type IV gypsum products (Gelstone [R], BK Giulini Chemie, Ludwigshafen/Rh., Germany). The dimensional accuracy of the obtained casts was assessed by measuring the inter-abutment measurements (between the abutments) and the intra-abutment measurements (diameter and height of the abutments). These measurements were performed using a universal measuring microscope (Olympus stereomicroscope B061 Imaging Corp. Tokyo, Japan) with a precision of 0.001 mm. The dimensions of the stone casts from the study groups were then compared to those of the control group. Data analysis was performed using a one-way ANOVA with a significance level of $\alpha = 0.05$.
Results: AFFINIS impressions subjected to chemical disinfection in 5.25 % NaOCl and 2 % glutaraldehyde with different immersion times showed slight expansion in the intra- and inter-abutment measurements. The impressions autoclaved at 134 °C for 18 min showed slight shrinkage in the intra- and inter-abutment measurements. The dimensional change was statistically non-significant, and the percent of dimensional changes within the experimental groups was within the clinically accepted limit ($\alpha < 0.5$).
Conclusion: AFFINIS polyvinyl siloxanes retain dimensional stability suitable for clinical use when subjected to chemical disinfection and steam autoclaving.

1. Introduction

Dental impressions are an essential component of restorative dentistry. They are used to create an accurate replica of a patient's teeth and oral structures to fabricate dental restorations or prostheses (Lim et al., 2021). Although digital impressions have many benefits, traditional impressions are still an essential part of dental practices and will continue to be used for the foreseeable future (Alenezi et al., 2022). Polyvinylsiloxane (PVS) is one of the impression materials introduced in the dental market and has the following main advantages (Raheef,

* Corresponding author at: Department of Substitutive Dental Sciences, College of Dentistry, Imam Abdulrahman Bin Faisal University, P.O. Box 1982, Dammam 31441, Saudi Arabia.
E-mail address: ntyoussef@iau.edu.sa (N. Taymour).

https://doi.org/10.1016/j.sdentj.2024.01.016
Received 17 November 2023; Received in revised form 30 January 2024; Accepted 31 January 2024
Available online 4 February 2024

2021): it can reproduce fine details accurately, allowing for precise crown, bridge, and implant preparation (Baldissara et al., 2021). The excellent dimensional stability of PVS impression material ensures accurate reproduction of the oral tissues (Aivatzidou et al., 2021). PVS are intrinsically hydrophobic; however, other introduced types of PVS are relatively hydrophilic, where the addition of surfactant enhanced the surface wettability of the oral tissues and improved the impression accuracy (Shervani et al., 2022). AFFINIS impressions are a new formulation of PVS addition silicones consisting of long macromolecular chains exhibiting a sequential arrangement of silicon and oxygen atoms. The linkages between silicon and oxygen create an exceptionally flexible inorganic network with notable physicochemical properties, such as thermal stability and chemical inertness. The remaining valences of silicon are linked to organic groups, mainly methyl groups (CH_3), phenyl, vinyl, or hydrogen (Kherroub et al., 2017). AFFINIS impressions can undergo steam autoclaving and maintain dimensional stability to mitigate cross-infection effectively (Singer et al., 2022).

Disinfection is a crucial step in the dental impression process to reduce the risk of infection transmission between patients and dental professionals. However, disinfection can affect the general properties of impression materials (Weżgowiec et al., 2022). Disinfection can induce surface roughness and potentially modify the surface characteristics of impression materials, particularly silicones (Karaman et al., 2020). Chemical disinfection protocols could influence the dimensional stability of the impression. However, the changes are usually clinically irrelevant (Azevedo et al., 2019). Chemical disinfectants can affect the hydrophilic properties of PVS impression materials (Chidambaranathan and Balasubramanium, 2019).

Sodium Hypochlorite (NaOCl) and glutaraldehyde are commonly utilized disinfectants for immersion. The concentrations of glutaraldehyde ranged from 2 to 2.45 %, while NaOCl concentrations varied between 3 and 5.25 %. It is essential to highlight that while the overall effect of disinfection on the dimensional accuracy may be marginal, the use of the NaOCl disinfection method resulted in slightly more noticeable changes in the dimensional accuracy of PVS materials when compared to the untreated PVS impressions (Awod Bin Hassan et al., 2023).

With the emergence of the COVID-19 pandemic and the possibility of future unforeseen variants, it is crucial to disinfect dental impressions prior to using them for casting or sending them to the dental laboratory (Coccia, 2023). The American Dental Association (ADA) strongly advocates the immediate disinfection of dental impressions immediately after removal from the patient's mouth. This precautionary measure is essential to reduce the risk of cross-infection between patients and dental personnel in dental clinics and laboratories (Barenghi et al., 2019).

No single disinfectant can be universally applied to all types of impression materials (Hardan et al., 2022). The most commonly employed method for dental impression sterilization in clinics is through a chemical process, achieved by immersing them in or applying a disinfectant spray (Al Mortadi et al., 2019). Immersion is the most reliable method, as it guarantees that all the impression and tray surfaces are exposed to disinfectant (Ahila and Subramaniam, 2012, Dapello-Zevallos et al., 2022). The antimicrobial effectiveness of glutaraldehyde depends on the concentration and duration of exposure to the compound. Glutaraldehyde's antimicrobial action results from alkylating sulfhydryl, hydroxyl, carboxyl, and amino groups found in microorganisms (Hardan et al., 2022).

Sodium hypochlorite is another frequently used chemical disinfectant for this purpose. The antimicrobial activity of sodium hypochlorite is related to the presence of chlorine, which inhibits essential bacterial enzymes, leading to irreversible enzymatic inactivation in bacteria and lipid and fatty acid degradation (Estrela et al., 2002). However, it should be emphasized that this procedure ensures disinfection rather than complete sterilization (Gothwal et al., 2019).

Physical disinfection methods are performed by elevating the temperature and encompass techniques such as autoclaving, ultraviolet light disinfection, and microwave irradiation. Autoclaving is regarded as effective in managing cross-infection and preventing contamination by microorganisms. It is noteworthy that chemical disinfection is potent against organisms in their vegetative forms but does not eradicate viruses or bacterial spores. Regarding dental impression disinfections, it is crucial to consider both the antibacterial effectiveness and its impact on the dimensional stability of impression materials (AlZain, 2020). Using typical sterilization techniques like extended immersion or high-temperature approaches like autoclaving could impact the physical characteristics and dimensions of PVS impressions (Asopa et al., 2020).

The precision of dental impressions is influenced by various factors, including the impression technique, the type of impression tray used, and the inherent properties of the impression materials (Perakis et al., 2004). Obtaining a precise impression is a crucial step in fabricating and properly fitting dental prostheses (Gupta et al., 2020). The advancement of new materials and technologies to enhance infection control has led to the development of polyvinyl siloxane impression materials that can be sterilized using steam autoclaving. Having impressions that remain dimensionally stable after autoclaving is highly advantageous in effectively preventing cross-infection and contamination (Reddy et al., 2013).

The ADA specification No. 19 demonstrates that elastomers should exhibit no more than ± 0.5 % to be classified as dimensionally accurate over time (Daou, 2010). According to the ISO 4823 specification (Revised American Dental Association Specification no. 19 for Non-aqueous 1977), dimensional changes of less than 1.5 % to elastomeric impression materials are clinically acceptable. While autoclaving is commonly considered the most efficient method of sterilization, there is a lack of research on how autoclaving affects the dimensional stability of polyvinyl siloxane elastomeric impression materials. Notably, autoclavable polyvinyl siloxane impression materials can withstand steam autoclaving temperatures up to 134 °C (Reddy et al., 2013).

The novelty of this study lies in its investigation of the impact of autoclaving on the dimensional accuracy of PVS impressions, an area that has received limited attention in existing dental research. PVS impressions are widely used in dentistry due to their precise detail reproduction and dimensional stability, but their response to autoclaving has not been thoroughly explored. The null hypothesis theory states that there is no significance in the dimensional accuracy of PVS impressions with different disinfection methods. The current study aimed to assess and compare the dimensional stability of autoclavable polyvinyl siloxane impression material when subjected to immersion in chemical disinfectant and autoclaving methods.

2. Materials and methods

In the present study, the sample size was determined according to the results obtained from a previous study (Hafezeqoran et al., 2021). Considering $\alpha = 0.05$, a power of 80 %, and a mean and standard deviation of 0.3 ± 0.2, respectively, eight samples were estimated to measure the variable of dimensional accuracy in each disinfection technique. However, to enhance the accuracy of this study, 10 impression samples were considered for each group ($n = 10$), and a total of 40 specimens of vinylpolysiloxane impression materials (AFFINIS) were used for the control group and each disinfection technique.

2.1. Stainless steel model fabrication

A stainless steel master model containing three full veneer crown preparations was fabricated on a lathe according to ANSI/ADA specification No. 19 (Aivatzidou et al., 2021) (Fig. 1A). The dimensions of the prepared abutments were 6.12 mm in occlusogingival height, 3.88 mm in buccolingual, and 3.87 mm in mesiodistal diameter with 1.00 mm circumferential shoulder finish line, and 10.79 mm distance between the abutments with a total inter-abutment distance of 25.45 mm between

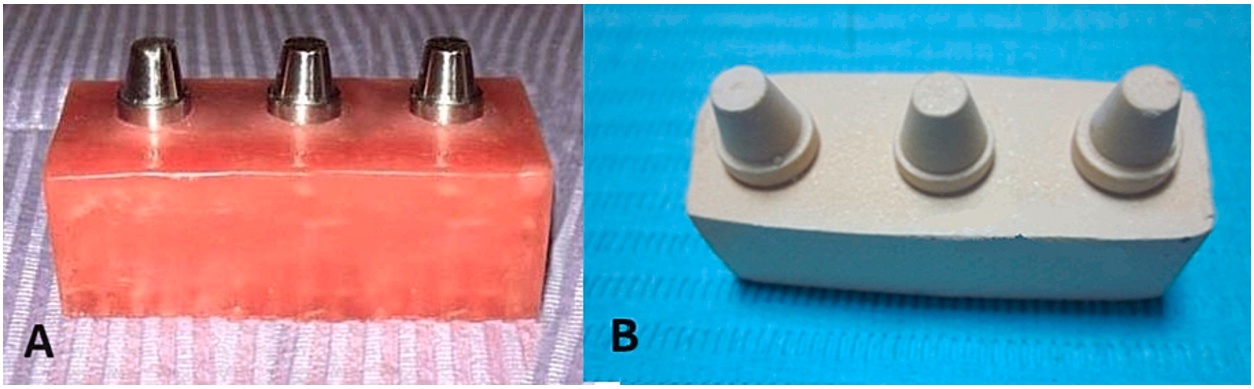

Fig. 1. A) Master model. B) Poured stone model.

the first and third abutments. Each preparation was made with six-degree taper. The occlusal surface of all the abutments was on the same plane, and the reference grooves were established on the occlusal and axial surfaces of the abutments for accurate measurements of the intra- and inter-abutment distances. An auto-polymerizing acrylic resin base was fabricated to hold the stainless steel model. This acrylic resin base was designed so that the tray borders had corresponding grooves in the resin base to allow the consistent positioning of the impression tray on the stainless steel model during each use. All procedures were done in an ambient laboratory atmosphere (23 ± 2 °C).

2.2. Samples' preparations

Forty impressions of the master stainless steel model were made using autoclavable monophase addition silicone impression materials (AFFINIS, Coltene/Whaledent, Altstatten, Switzerland). To simulate oral temperature conditions, the die was warmed in a 35 °C water bath (Zhengji HH-S4, Jiangsu, China) for 15 min before starting the impression procedure. In the experimental study, to ensure standardization and minimize human errors, one investigator conducted the impression procedures, while another investigator was assigned to measure the resultant casts, with both investigators undergoing proper training and calibration. Additionally, meticulous measures, including proper illumination and regular calibration of the stereomicroscope, were undertaken to enhance the accuracy and reproducibility of specimen observations and measurements. One stainless steel medium-sized sectional tray was employed, and tray adhesive (Coltène Adhesive AC (autoclavable, for metal trays), Altstatten, Switzerland) from the impression material manufacturer was thinly applied to the trays' inner surface and allowed to dry for 15 min. The one-step impression technique was carried out using AFFINIS Monophase (medium viscosity impression material) mixed with an auto-mixing device per the manufacturer's instructions. This material was injected into the tray and around abutments with careful attention to avoid air entrapment. A calibrated syringe was used to ensure that the same amount of PVS impression material was injected for each impression, eight full hand closures of the auto-mixing device were used to dispense the impression material in the stock tray, and two full hand closures were used to dispense the impression material on each abutment. Then, the stock tray was seated over the model carefully using a static load device, and a 1.2 kg weight was placed on top until the tray borders became stable and firmly in contact with the corresponding grooves in the model base to allow the reproducible positioning of the impression tray on the stainless steel model every time and to standardize the tray seating and impression material thickness in all test specimens. Impressions were removed vertically after 12 min to minimize stress on the set material and rinsed under cold water. Each impression was inspected visually to ensure a clear reproduction of the reference points.

Four groups were established to assess the disinfection and sterilization methods for impressions: Control Group A: Impressions were left untreated after being separated from the stainless steel model. Group B: Impressions were immersed in sodium hypochlorite (5.25 %) for 10 min at room temperature, per the manufacturer's guidelines. Group C: Impressions were immersed in glutaraldehyde (2 %) for 30 min at room temperature, following the manufacturer's instructions. Group D: Impressions were sealed in autoclave pouches and subjected to steam sterilization using a Millenium autoclave (W&H Sterilization Srl., 24,060 Brusaporto, Italy) Type B at 134 °C for 18 min, following the manufacturer's recommendations. Table 1 The color indicator on the pouches verified successful sterilization. One hour is required for the impressions to reach room temperature after this process.

After each disinfection or sterilization method, all impressions were rinsed with cold tap water for 10 s, dried with forced air, and kept in a laboratory atmosphere for 24 h before pouring (Surendra et al., 2011). The impressions were poured in type IV dental stone (Gelstone R, BK Giulini Chemie, Ludwigshafen/Rh., Germany) according to manufacturer instructions (Fig. 1B). The gypsum was filled slightly above the impression tray to ensure proper sealing of the impression. All retrieved casts were left at room temperature for 24 h before starting any measurements (Surendra et al., 2011).

2.3. Measurements of dimensional stability

To assess dimensional accuracy, the measurements on these stone casts were compared to both the baseline measurements of the stainless steel master model and the measurements of casts poured from the control group impressions. Three different dimensions, including the height and diameter of abutments and the distance between the abutments, were measured on both the casts from the control group impressions and the stone casts from the test impressions (Fig. 2A, B, and C). These measurements were conducted by a single investigator and were performed three times for each parameter. A stereomicroscope (Olympus stereomicroscope B061 Imaging Corp. Tokyo, Japan) with a 30x magnification was used. The stereomicroscope provides increased visibility and multiple magnification levels, improving the precision and

Table 1
Specimens' grouping, coding, and identification.

Groups	Number of specimens	Identifications
A	10	Stone casts produced from unsterilized impressions.
B	10	Stone casts produced from impressions were disinfected with 5.25 % sodium hypochlorite for 10 min.
C	10	Stone casts produced from impressions were disinfected with 2 % glutaraldehyde for 30 min.
D	10	Stone casts produced from impressions autoclaved at 134 °C for 18 min.

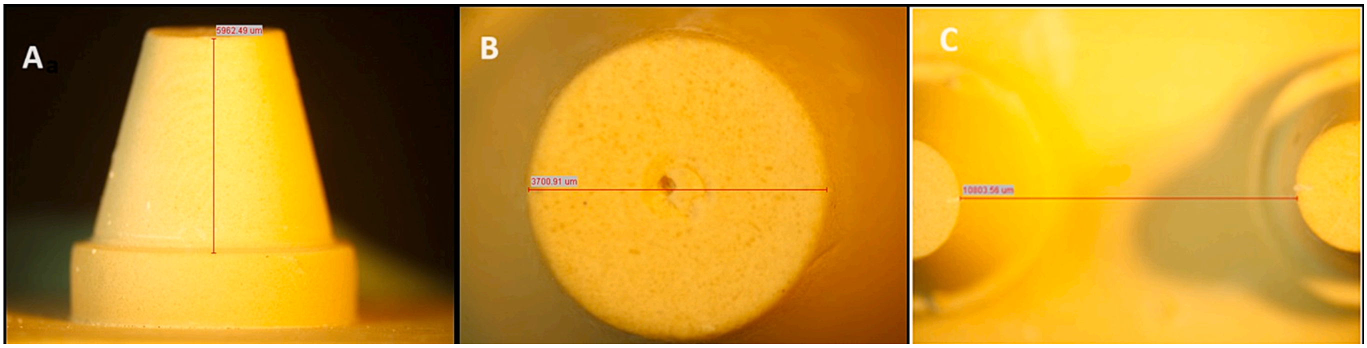

Fig. 2. A) The stereo image shows the occlusogingival height of the abutment. B) The stereo image shows the mesiodistal diameter of the abutment. C) The stereo image shows the inter-abutment measurement.

accuracy of dental procedures (Kajan et al., 2015). Though more straightforward, fully integrated digital tools may have limited sample viewing options. Optical microscopes offer versatility by enabling contrasting techniques like differential interference contrast, phase contrast, and fluorescence.

Additionally, optical microscopes allow the integration of a microscopy camera, offering both high optical quality through eyepieces and the convenience of viewing the digital image on a monitor (Mertz, 2011). Most studies evaluating the impression materials' accuracy and/or dimensional stability use a measuring microscope. The main advantage of this method is its precision in measuring the linear distance between two points in a specimen. Furthermore, measurements conducted following ISO standards are considered scientifically acceptable (Oliveira et al., 2021). The stereomicroscope was used with a mechanical stage to measure the inter- and intra-abutment distances of the dental impressions. The mechanical stage allows for precise movement of the specimen, which is necessary for accurate measurements. The Olympus stereomicroscope B061 has a built-in camera mount that produces accurate results. The camera mount enables easy sharing and display of images using wireless LAN-enabled cameras. The heads-up display allows easy viewing in a group setting.

2.4. Data analysis

Data was imported into the Excel sheet for analysis purposes. The normality test was done before analysis, and the P-values from the Kolmogorov-Smirnov test indicated that the data was normally distributed. Statistical analysis was carried out using a one-way ANOVA (material x disinfectant) to compare groups. P-values less than and equal to 0.05 were considered statistically significant. SPSS version 22, Inc., IBM was used for statistical analysis (Asopa et al., 2020). Dimensional accuracy expressed as a percentage (L) was calculated following ISO 4823 (1977) using the equation $L = [(L2 - L1) / L1] \times 100$, where L1 is the original dimension on the master model and L2 is the final dimension after disinfection /autoclaving. Then, 100 % was added to the equation results (Guiraldo et al., 2017) and the results of the dimensional accuracy (%).

3. Results

Regarding the intra-abutment measurements (MD, BL, and OG), the dimensions of the abutments produced from chemical disinfection of AFFINIS impressions (Groups B and C) showed slight expansion, with the maximum expansion of 0.52 % shown in Group B. Meanwhile, the dimensions of the abutments retrieved from autoclavable AFFINIS impressions (Group D) showed slight shrinkage, with maximum shrinkage (0.35 %). However, the difference between the experimental groups was statistically insignificant (P-value < 0.05), as well as the percent change in all groups is clinically acceptable (±0.5 %). Table 2

Regarding the inter-abutment distance, group B and C (disinfected AFFINIS) impressions showed slight expansion; however, the percent of dimensional changes were −0.27 % and −0.11 %, respectively. The changes were statistically and clinically insignificant (P-value = 0.782), and the percentage change was less than 0.5. Meanwhile, group D (autoclaved AFFINIS) impressions showed slight shrinkage, with the percentage of dimensional changes being 0.35 %. Table 2

4. Discussion

This study examined the impact of various disinfection and sterilization methods on the dimensional stability of autoclavable PVS impressions (AFFINIS) using 5.25 % sodium hypochlorite, 2 % glutaraldehyde, and steam autoclaving. The study's null hypothesis was accepted as there is no significance in dimension accuracy after different disinfection/sterilization methods.

This study showed that the recovered casts from the AFFINIS

Table 2
Comparison between the mean difference, standard deviation of dimensions (in mm) of the study groups and the control group, and the percent of dimensional changes between the study groups and the master model.

Dimensions (mm)	Master Model (mm)	Group A (no treatment)	%	Group B (5.25 % NaOCl)	%	Group C (2 % Glutaraldehyde)	%	Group D (Autoclave)	%	P
MD (Mean ± SD)	3.78	3.79 ± 0.12	0.26	3.80 ± 0.15	−0.52	3.79 ± 0.14	−0.26	3.77 ± 0.13	0.26	0.9671
BL (Mean ± SD)	3.98	3.99 ± 0.13	0.25	4.00 ± 0.09	−0.50	3.99 ± 0.07	−0.25	3.87 ± 0.08	0.25	0.9589
OG (Mean ± SD)	6.12	6.15 ± 0.31	0.49	6.15 ± 0.32	−0.49	6.13 ± 0.18	−0.16	6.11 ± 0.11	0.32	0.9803
Inter-abutment (Mean ± SD)	25.45	25.46 ± 0.37	0.03	25.38 ± 0.53	−0.27	25.50 ± 0.21	−0.11	25.54 ± 0.21	0.35	0.7759

P: P-value for the F test (ANOVA) for comparing between different groups.
*: Statistically significant at $P \leq 0.05$.

impressions subjected to chemical disinfection showed slight expansion in all the intra-abutment and inter-abutment measurements. However, the difference was statistically non-significant, and the percent of dimensional changes lies within the clinically accepted limit (±0.5). This might be due to the presence of methyl groups in the PVS polymer chain, which makes the material less polar and hydrophobic. Kavita et al. found that PVS impressions are dimensionally stable after immersion in NaOCl and glutaraldehyde (Kavita et al., 2021). Forrester et al. investigated the dimensional stability of different addition silicone impressions after chemical disinfection, and they concluded that none of the measured dimensions taken from the casts were significantly different from those taken from the control group (Forrester-Baker et al., 2005). Abado et al. investigated the dimensional stability of elastomeric materials based on the disinfection methods applied, and impressions were subjected to chemical disinfection with different durations (Adabo et al., 1999). The study found no significant difference between the groups, and they were comparable to the control group.

Additionally, Weżgowiec et al. found that the chemical immersion disinfection method had no significant impact on the dimensional stability of the PVS impressions (Weżgowiec et al., 2022). However, Khatri et al. reported significant dimensional changes at a 3 % NaOCl concentration using the same duration for immersion disinfection (Khatri et al., 2020). The observed dimensional changes might have been influenced by the 12-hour waiting period after disinfection, which could explain the variation in the results.

It was observed from the results that with prolonged immersion of AFFINIS impressions in chemical disinfectant, the dimensional changes were still within the clinically accepted range (±0.5 %) (R Mohd et al., 2021) thanks to the unique chemical structure of PVS impressions that contributes to their water resistance. The polymer chains are composed of alternating silicon and oxygen atoms, which form a highly cross-linked network that is resistant to water absorption (González Calderón et al., 2020). This comes in agreement with Melilli et al., who investigated the effect of prolonged immersion of PVS in 2 % glutaraldehyde and concluded that there was no significant difference in the dimensions of disinfected and non-disinfected discs after prolonged storage (Melilli et al., 2008). Similarly, Helal and Mohamed concluded that chemical disinfection with 2 % glutaraldehyde for one hour did not affect the dimensional stability of PVS impressions (Helal and Mohamed, 2005). However, Nimonkar et al. found that the dimensional changes were significant in the samples subjected to 2 % glutaraldehyde disinfectant (Nimonkar et al., 2019). Another study by Duseja et al. found that PVS impressions immersed in 2 % glutaraldehyde resulted in statistically significant expansion compared to non-disinfected impressions (Duseja et al., 2014a, 2014b). Gómez-Polo found that the pouring time of PVS impressions influenced dimensional stability, indicating that prolonged immersion in glutaraldehyde may affect accuracy (Gomez-Polo et al., 2012).

When comparing the percent of dimensional changes from the recovered casts from glutaraldehyde and NaOCl disinfected impressions, it was found that the casts produced from impression immersed in glutaraldehyde showed less expansion in comparison to that produced from NaOCl immersion, which might be due to that the glutaraldehyde is a less reactive chemical disinfectant than sodium hypochlorite, which makes it less likely to react with PVS impression material and affect its dimensional stability (Samra and Bhide, 2018). This comes in accordance with Khinnavar et al., who indicated that 2 % glutaraldehyde is a more effective disinfectant than 0.525 % sodium hypochlorite (Khinnavar et al., 2015). Another study demonstrated that glutaraldehyde is more effective in achieving complete disinfection without compromising the surface details of poured casts (Qiu et al., 2023). On the contrary, a previous study by Hiraguchi demonstrated that long-term disinfection of addition-type silicone impressions in 2 % glutaraldehyde caused significant dimensional changes in the retrieved stone casts (Hiraguchi et al., 2013).

From the results of the present study, it was observed that the retrieved casts from autoclaved AFFINIS impressions showed slight shrinkage in the inter- and intra-abutment measurements. However, the percentage of dimensional changes lies within the clinically accepted range. The reason could be that PVS impressions may exhibit a rebound effect, meaning they may expand after being compressed. Therefore, it is recommended to delay autoclaving for at least 24 h to leverage the rebound effect exhibited by the material (Nagle et al., 2023). Despite the polymerization shrinkage of polydimethylsiloxane, the hydrophobic nature of PVS makes it less susceptible to water sorption being affected by steam autoclaving (Khan and ALI KHAN 2015, Awod Bin Hassan et al., 2023). Another reason behind the dimensional stability of PVS impression under steam autoclaving might be the presence of high-temperature resistant rubber additives (polymetallic organosiloxane), which were proved to have high-temperature resistance up to 320–350 °C for long-term moisture and steam resistance (Chruściel, 2022). Our findings come in accordance with Mohd et al., who found that the changes in dimensions of PVS exposed to microwave irradiation and chemical disinfection have been noted to fall within the clinically acceptable limit established by the ANSI/ADA standard (R Mohd et al., 2021). In addition, Asopa et al. concluded that the linear dimensional changes in autoclaved PVS impressions fall within the ADA clinically accepted ranges; hence PVS impression is acceptable for short–span prosthesis fabrication (Asopa et al., 2020). Reddy et al. subjected PVS samples to an autoclaving cycle under 134 °C for 18 min; however, they recommended autoclavable PVS material for making multiple units of restorations rather than full mouth restorations (Reddy et al., 2013). Tjan stated that an autoclaved PVS impression with approximately 50 μm dimensional change was acceptable (Tjan et al., 1986). Surendra et al. studied the effect of autoclaving on the dimensional accuracy of a PVS (AFFINIS) impression material, and they found a higher mean dimensional change immediately after autoclaving compared to the other two time intervals, i.e., before autoclaving and 24 h after autoclaving (Surendra et al., 2011).

The clinical significance of this study holds significant relevance for dental practice. The outcomes offer valuable insights into the impact of chemical disinfection and sterilization on the dimensional stability of PVS impression material. The results underscore the necessity for meticulous consideration when selecting disinfection and sterilization methods for PVS impressions. It is imperative to optimize these procedures, considering the chemical properties of disinfectants, to ensure the dimensional accuracy and stability of PVS impressions. Furthermore, the study emphasizes the importance of comprehending the behavior of PVS impressions under heat sterilization, contributing valuable information for establishing best practices in dental settings. Ultimately, these findings directly impact the quality of patient care and the precision of dental restorations.

The strength of this study is that it was conducted under controlled conditions to ensure that the results were not affected by external factors. The study used a reproducible methodology to ensure that other researchers could replicate the results. In addition, the study has compared the effect of autoclaving, as a time-efficient sterilization method, to other conventional disinfection methods on PVS impressions. It is important to note that when pouring impressions after autoclaving, a delay of at least 24 h is recommended to benefit from the rebound phenomenon exhibited by this material.

Limitations: This study attempted to evaluate the impact of chemical disinfection and autoclaving on the dimensional stability of one type of PVS impression. Although the materials underwent non-significant dimensional changes, they were not tested after longer storage or immersion times in disinfectant or different sterilization cycles. It would be beneficial to study the effect of longer storage on the dimensional stability of PVS in addition to studying the effect of other types of disinfectants, longer immersion periods, and different autoclaving cycles.

5. Conclusion

The study's findings suggest that the dimensional changes in the tested AFFINIS PVS impressions after disinfection and autoclaving fall within the clinically recommended limits. Consequently, autoclavable PVS impressions could be clinically suitable for fabricating short-span dental prostheses. The potential of autoclavable PVS impression material to limit cross infections in dental offices, including viruses like COVID-19, shows promising results.

Ethical statement

This research does not require ethical approval. I followed the Helsinki declaration.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRediT authorship contribution statement

Noha Taymour: Conceptualization, Methodology, Investigation, Writing – original draft, Project administration. **Sanaa Hussein Abdel Kader:** Methodology, Validation, Formal analysis, Writing – review & editing. **Moustafa N. Aboushelib:** Methodology, Formal analysis, Data curation, Writing – review & editing, Visualization. **Mohammed M. Gad:** Writing – review & editing, Supervision, Project administration.

Acknowledgment

The author acknowledges Mr. Farraz Farooqi, the biostatistician at the College of Dentistry, Imam Abdulrahman Bin Faisal University, for his help in the statistical analysis.

References

Adabo, G.L., Zanarotti, E., Fonseca, R.G., et al., 1999. Effect of disinfectant agents on dimensional stability of elastomeric impression materials. J. Prosthet. Dent. 81, 621–624. https://doi.org/10.1016/s0022-3913(99)70219-2.

Ahila, S. C. and E. Subramaniam, 2012. Comparative evaluation of dimensional stability and surface quality of gypsum casts retrieved from disinfected addition silicone impressions at various time intervals: An in vitro study.

Aivatzidou, K., Kamalakidis, S.N., Emmanouil, I., et al., 2021. Comparative study of dimensional stability and detail reproduction of reformulated and nonreformulated elastomeric impression materials. Journal of Prosthodontics : Official Journal of the American College of Prosthodontists 30, 345–350. https://doi.org/10.1111/jopr.13248.

Al Mortadi, N., Al-Khatib, A., Alzoubi, K.H., et al., 2019. Disinfection of dental impressions: knowledge and practice among dental technicians. Clin. Cosmet. Investig. Dent. 11, 103–108. https://doi.org/10.2147/ccide.S205144.

Alenezi, A., Yehya, M., Alkhodary, M., 2022. Effect of full arch two scanning techniques on the accuracy of overdenture conventional and CAD/CAM Co-Cr bars. The Saudi Dental Journal. 34, 553–564. https://doi.org/10.1016/j.sdentj.2022.08.007.

AlZain, S., 2020. 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 Dental J. 32, 161–170. https://doi.org/10.1016/j.sdentj.2019.12.003.

Asopa, S., Padiyar, U., Verma, S., et al., 2020. Effect of heat sterilization and chemical method of sterilization on the polyvinyl siloxane impression material. A comparative study. J. Family Med. Prim. Care. 9, 1348. https://doi.org/10.4103/jfmpc.jfmpc_1122_19.

Azevedo, M.J., Correia, I., Portela, A., et al., 2019. A simple and effective method for addition silicone impression disinfection. J. Adv. Prosthodont. 11, 155–161.

Baldissara, P., Koci, B., Messias, A.M., et al., 2021. Assessment of impression material accuracy in complete-arch restorations on four implants. J. Prosthet. Dent. 126, 763–771.

Barenghi, L., Barenghi, A., Cadeo, C., et al., 2019. Innovation by Computer-Aided Design/Computer-Aided Manufacturing Technology: A Look at Infection Prevention in Dental Settings. Biomed. Res. Int. 2019, 6092018. https://doi.org/10.1155/2019/6092018.

Chidambaranathan, A.S., Balasubramanium, M., 2019. Comprehensive review and comparison of the disinfection techniques currently available in the literature. J. Prosthodont. 28, e849–e856.

Chruściel, J. J., 2022. Silicon-Based Polymers and Materials, Walter de Gruyter GmbH & Co KG.183.

Coccia, M., 2023. Sources, diffusion and prediction in COVID-19 pandemic: lessons learned to face next health emergency. AIMS Public Health. 10, 145.

Daou, E.E., 2010. The elastomers for complete denture impression: A review of the literature. Saudi Dent J. 22, 153–160. https://doi.org/10.1016/j.sdentj.2010.07.005.

Dapello-Zevallos, G.M., San Miguel-Ramírez, K.N.M., Febre-Cuibin, K.S., et al., 2022. Disinfection of dental impression materials and its effects on dimensional changes: a literature review. Revista Odontológica Mexicana. 25, 154–159.

Duseja, S., Shah, D., Vaishnav, K., et al., 2014a. Accuracy of Different Elastomeric Impression Materials Using Dual Arch Impression Trays: An In Vitro Study. Adv. Hum. Biol. 4, 3–8.

Duseja, S.S., Shah, R., Shah, D.S., et al., 2014b. Dimensional measurement accuracy of recent polyether and addition silicone monophase impression materials after immersion in various disinfectants: An in vitro study. Int. J. Healthcare Biomed. Res. 2 (4), 87–97.

Estrela, C., Estrela, C.R., Barbin, E.L., et al., 2002. Mechanism of action of sodium hypochlorite. Braz. Dent. J. 13, 113–117. https://doi.org/10.1590/s0103-64402002000200007.

Forrester-Baker, L., Seymour, K.G., Samarawickrama, D., et al., 2005. A comparison of dimensional accuracy between three different addition cured silicone impression materials. Eur. J. Prosthodont. Restor. Dent. 13, 69–74.

Gomez-Polo, M., Celemin, A., del Rio, J., et al., 2012. Influence of technique and pouring time on dimensional stability of polyvinyl siloxane and polyether impressions. Int. J. Prosthodont. 25, 353–356.

González Calderón, J.A., Contreras López, D., Pérez, E., et al., 2020. Polysiloxanes as polymer matrices in biomedical engineering: Their interesting properties as the reason for the use in medical sciences. Polym. Bull. 77, 2749–2817.

Gothwal, G., Meena, S., Padiyar, U.N., et al., 2019. Comparative evaluation of elastic recovery of three different elastomeric impression materials on chemical disinfection and autoclaving: An in vitro study. J. Indian Prosthodont. Soc. 19, 345–352. https://doi.org/10.4103/jips.jips_277_19.

Guiraldo, R., Berger, S., Siqueira, R., et al., 2017. Surface detail reproduction and dimensional accuracy of molds: influence of disinfectant solutions and elastomeric impression materials. Acta Odontologica Latinoamericana : AOL. 30, 13–18.

Gupta, M., George, V., Balakrishnan, D., 2020. A comparative evaluation of tear strength and tensile strength of autoclavable and non-autoclavable vinylpolysiloxane impression material: An <i>in vitro</i> study. J. Int. Oral Health. 12, 153–157. https://doi.org/10.4103/jioh.jioh_212_19.

Hafezeqoran, A., Rahbar, M., Koodaryan, R., et al., 2021. Comparing the Dimensional Accuracy of Casts Obtained from Two Types of Silicone Impression Materials in Different Impression Techniques and Frequent Times of Cast Preparation. Int. J. Dentist. 2021, 9977478. https://doi.org/10.1155/2021/9977478.

Hardan, L., Bourgi, R., Cuevas-Suárez, C.E., et al., 2022. Disinfection Procedures and Their Effect on the Microorganism Colonization of Dental Impression Materials: A Systematic Review and Meta-Analysis of In Vitro Studies. Bioengineering (basel, Switzerland). 9 https://doi.org/10.3390/bioengineering9030123.

Awod Bin Hassan, S., A. Ali F Alshadidi, L. Ibrahim N Aldosari, et al., 2023. Effect of chemical disinfection on the dimensional stability of polyvinyl ether siloxane impression material: a systemic review and meta-analysis. BMC Oral Health. 23, 471. 10.1186/s12903-023-03168-8.

Helal, M., Mohamed, A.-N., 2005. The effect of different disinfection and sterilization methods on the accuracy and viscoelastic behaviour of rubber base impression material. Al-Azhar Journal of Dental Science. 8, 239–249.

Hiraguchi, H., Kaketani, M., Hirose, H., et al., 2013. Dimensional changes in stone casts resulting from long-term immersion of addition-type silicone rubber impressions in disinfectant solutions. Dent. Mater. J. 32, 361–366. https://doi.org/10.4012/dmj.2012-159.

Kajan, Z.D., Davalloo, R.T., Tavangar, M., et al., 2015. The effects of noise reduction, sharpening, enhancement, and image magnification on diagnostic accuracy of a photostimulable phosphor system in the detection of non-cavitated approximal dental caries. Imaging Science in Dentistry. 45, 81–87.

Karaman, T., OzTeKin, F., TeKin, S., 2020. Effect of application time of two different disinfectants on the surface roughness of an elastomeric impression material. J. Clin. Diagn. Res. 14.

Kavita, K., Reddy, K.R.P., Reddy, K.R.M., et al., 2021. Assessment of Effect of Different Sterilization Agents on Dimensional Accuracy of Different Impression Materials in Implant Prosthesis - An In vitro Study. J. Pharm. Bioallied Sci. 13, S1620–S1623. https://doi.org/10.4103/jpbs.jpbs_315_21.

Khan, A., Ali Khan, T., 2015. Dimensional stability of vinylsiloxanether impression material after autoclave sterilization-an in vitro study. Pakistan Oral Dental J. 35, 535.

Khatri, M., Mantri, S.S., Deogade, S.C., et al., 2020. Effect of Chemical Disinfection on Surface Detail Reproduction and Dimensional Stability of a New Vinyl Polyether Silicone Elastomeric Impression Material. Contempor. Clin. Dentistry. 11, 10–14. https://doi.org/10.4103/ccd.ccd_9_19.

Kherroub, D.E., Belbachir, M., Lamouri, S., 2017. Synthesis and Characterization of Polyvinylmethylsiloxanes by Cationic Polymerization Using a Solid Green Catalyst. e-Polymers 17, 439–448.

Khinnavar, P.K., Kumar, B.H., Nandeeshwar, D.B., 2015. An in vitro study to evaluate the effect on dimensional changes of elastomers during cold sterilization. J. Indian Prosthodont. Soc. 15, 131–137. https://doi.org/10.4103/0972-4052.155034.

Lim, J.-H., Mangal, U., Nam, N.-E., et al., 2021. A comparison of accuracy of different dental restorative materials between intraoral scanning and conventional impression-taking: An in vitro study. Materials. 14, 2060.

Melilli, D., Rallo, A., Cassaro, A., et al., 2008. The Effect of immersion disinfection procedures on dimensional stability of two elastomeric impression materials. J. Oral Sci. 50, 441–446. https://doi.org/10.2334/josnusd.50.441.
Mertz, J., 2011. Optical sectioning microscopy with planar or structured illumination. Nat. Methods 8, 811–819.
R Mohd, N., R. A. Omar and E. A. Etajuri, 2021. Dimensional Stability of Elastomeric Impression Material After Disinfection Immersion and Microwave Irradiation. The Open Dentistry Journal. 15.
Nagle, N., Sony, M., Jain, D., et al., 2023. Comparative Evaluation of Dimensional Accuracy of Autoclavable Polyvinyl Siloxane Impression Material Using Different Methods of Sterilization: An in-Vitro Study. Int. J. Innov. Sci. Res. Technol. 8, 2012–2019.
Nimonkar, S.V., Belkhode, V.M., Godbole, S.R., et al., 2019. Comparative Evaluation of the Effect of Chemical Disinfectants and Ultraviolet Disinfection on Dimensional Stability of the Polyvinyl Siloxane Impressions. J. Int. Soc. Prev. Commun. Dentist. 9, 152–158. https://doi.org/10.4103/jispcd.JISPCD_406_18.
Oliveira, A.R.B.d., Sinhoreti, M.A.C., Amaral, M., et al., 2021. Dimensional change of impression materials for dental prothesis using different measuring methods. Matéria (rio De Janeiro) 26.
Perakis, N., Belser, U., Magne, P., 2004. Final impressions: A review of material properties and description of a current technique. Int. J. Periodontics Restorative Dent. 24, 109–117.
Qiu, Y., Xu, J., Xu, Y., et al., 2023. Disinfection efficacy of sodium hypochlorite and glutaraldehyde and their effects on the dimensional stability and surface properties of dental impressions: a systematic review. PeerJ 11, e14868.
Raheef, A.A., 2021. Impression materials and techniques used for complete dentures, Ministry of Higher Educati on &. Scientific Research University of Baghdad.
Reddy, S.M., Vijitha, D., Karthikeyan, S., et al., 2013. Evaluation of dimensional stability and accuracy of autoclavable polyvinyl siloxane impression material. J. Indian Prosthodont. Soc. 13, 546–550. https://doi.org/10.1007/s13191-012-0168-z.
Samra, R.K., Bhide, S.V., 2018. Comparative evaluation of dimensional stability of impression materials from developing countries and developed countries after disinfection with different immersion disinfectant systems and ultraviolet chamber. Saudi Dental Journal. 30, 125–141. https://doi.org/10.1016/j.sdentj.2017.11.005.
Shervani, A.R., Saxena, D., Aggarwal, S., et al., 2022. Evaluation and comparison of the effect of autoclave and chemical sterilization on the dimensional accuracy and stability of two elastomeric impression materials-an in vitro study. Int. J. Commun. Med. Public Health. 9, 3152.
Revised American Dental Association Specification no. 19 for Non-aqueous, E. D. I. M., 1977. Revised American Dental Association Specification no. 19 for Non-aqueous, Elastomeric Dental Impression Materials. J. Am. Dental Assoc. (1939). 94, 733-741. 10.14219/jada.archive.1977.0334.
Surendra, G.P., Anjum, A., Satish Babu, C.L., et al., 2011. Evaluation of dimensional stability of autoclavable elastomeric impression material. J. Indian Prosthodont. Soc. 11, 63–66. https://doi.org/10.1007/s13191-011-0061-1.
Tjan, A.H., Whang, S.B., Tjan, A.H., et al., 1986. Clinically oriented evaluation of the accuracy of commonly used impression materials. J. Prosthet. Dentist. 56, 4–8. https://doi.org/10.1016/0022-3913(86)90272-6.
Weżgowiec, J., Paradowska-Stolarz, A., Malysa, A., et al., 2022. Effects of Various Disinfection Methods on the Material Properties of Silicone Dental Impressions of Different Types and Viscosities. Int. J. Mol. Sci. 2022, 1–14. https://doi.org/10.3390/ijms231810859.