



# Disinfection of dental impression materials and its effects on dimensional changes: a literature review

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## ABSTRACT

A disinfectant must meet two fundamental requirements: be an effective antimicrobial agent and preserve the dimensional stability and surface details of the impression. This allows to obtain much more accurate plaster models that allow the fabrication of prostheses. The most recommended procedures are immersion and spraying, using disinfectant solutions such as sodium hypochlorite, glutaraldehyde, iodophors and phenols at different concentrations. The available impression materials were not originally formulated to disinfect, so there is the potential for disinfection procedures to alter the physical features of the impressions and consequently the characteristics of the plaster model. That is why the aim of this updated review is to know the effect of disinfectants on the dimensional stability of different impression materials after being subjected to different disinfection methods.

**Keywords:** Disinfection, impressions, dimensional stability.

## Desinfección de los materiales de impresión dental y sus efectos en los cambios dimensionales: una revisión de la literatura

### RESUMEN

Un desinfectante debe cumplir dos requisitos fundamentales: ser un agente antimicrobiano eficaz y preservar la estabilidad dimen-

sional y los detalles de la superficie de la impresión. Esto permite obtener modelos de yeso mucho más precisos que permiten la fabricación de prótesis. Los procedimientos más recomendados son la inmersión y la pulverización, utilizando soluciones desinfectantes como el hipoclorito de sodio, el glutaraldehído, los yodóforos y los fenoles a diferentes concentraciones. Los materiales de impresión disponibles no fueron formulados originalmente para desinfectar, por lo que existe la posibilidad de que los procedimientos de desinfección alteren las características físicas de las impresiones y, en consecuencia, las características del modelo de placa. Por ello, el objetivo de esta revisión actualizada es conocer el efecto de los desinfectantes sobre la estabilidad dimensional de diferentes materiales de impresión tras ser sometidos a distintos métodos de desinfección.

**Palabras clave:** Desinfección, impresiones, estabilidad dimensional.

## INTRODUCTION

Dental impressions are a common procedure in the area of Oral Rehabilitation,<sup>1</sup> performed in order to obtain a plaster model that facilitates the fabrication of prosthetic elements.<sup>2,3</sup>

When in contact with saliva, blood and bacterial plaque, these impressions can act as a vehicle for the transferring of microorganisms, posing a serious threat if the necessary precautions are not taken.<sup>4-6</sup> Therefore, disinfection procedures are required before pouring of the cast.<sup>3</sup>

Until 1991, to disinfect it was recommended the impressions washing under running water. However, research reveal that this procedure only partially eliminates bacteria, fungi and viruses.<sup>7,8</sup>

Subsequently, to control spreading of diseases, the American Dental Association (ADA) and the World Dental Federation (FDI) recommended disinfection of dental impressions immediately after removal from the mouth, either by immersion or spraying procedures, using disinfectant solutions.<sup>3,9,10</sup>

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The best known disinfectant solutions for dental impressions are sodium hypochlorite, glutaraldehyde, iodophors, phenols and chlorhexidine digluconate.<sup>8,11</sup> In addition, new methods for disinfection have been introduced, such as microwaves, autoclaving and ultraviolet (UV) light chambers.<sup>3,12</sup>

Disinfection process should not alter the impressions, that is, it should not cause dimensional changes on their surface.<sup>9</sup> Dimensional stability of dental materials is understood as the ability to register without being affected by the time, thus giving the operator a chance to get an adequate pouring.<sup>13</sup> This characteristic is an essential requirement in dental and laboratory practices to obtain accurate replicas and the prostheses fabrication.<sup>14</sup>

The available impression materials were not originally formulated to disinfect, so there is the potential for disinfection procedures to alter the physical features of the impressions and consequently the characteristics of the plaster model.<sup>15</sup>

This paper aim was to review the different recommended procedures for disinfection of dental impressions and their effect on the dimensional stability of impression materials.

## MATERIAL AND METHODS

A comprehensive search on the Scopus, PubMed/Medline, and EBSCO databases was performed using the following keywords: Disinfection; Impressions; Dimensional stability. Ninety-seven related articles were consulted, of which 27 were selected the most current, relevant and oriented to the disinfection of impression materials and its effect on dimensional stability.

## ANALYSIS OF THE INFORMATION

### Disinfection

Impression disinfection has become an essential issue of universal concern, due to the potential of contaminated impressions to cause cross-infection.<sup>16</sup>

Therefore, the purpose of disinfection is to prevent infection spreading from one patient to another and to maintain the security of avoiding contagion among the dental care team.<sup>6</sup>

The ADA recommends using at least an intermediate level disinfectant for dental impressions.<sup>6</sup> Disinfectant solutions routinely used in dentistry include sodium hypochlorite, glutaraldehyde, iodophor, and phenol. However, not all impression materials are compatible with all types of disinfectants, as the disinfectant effect could alter the properties of the impression material.<sup>17</sup>

### Disinfection methods

The ADA and the Centers for Disease Control and Prevention (CDC) suggest immersion and spraying as methods for disinfecting dental impressions with the use of a disinfectant solution.<sup>6</sup>

Immersion is the most reliable method as it ensures that all surfaces of the impression and tray contact the disinfectant;<sup>17</sup> it involves more time and cost as the disinfectants must be freshly prepared and have a limited shelf life.<sup>4</sup>

This method promotes the water absorption phenomena of hydrophilic impression materials, especially when they are immersed in the disinfectant for a long time, allowing chemical interactions between impressions and disinfectants. Immersion is preferable to disinfect hydrophobic impression materials such as vinyl polysiloxane and polysulfide.

Due to their hydrophilic nature, hydrocolloids and polyethers cannot be immersed for a long time since the imbibition phenomenon is favored, that is, water absorption is stimulated and in effect, they would be more prone to undergo dimensional changes.<sup>6,17</sup>

The ADA recommends using immersion preferably in elastomers because of its greater antiseptic efficacy and because it is able to compensate for the polymerization shrinkage of these materials, improving accuracy. However, it has been of great controversy to use it in polyethers or hydrocolloids due to its highly hydrophilic nature.<sup>15,18</sup>

On the other hand, spray disinfection is the preferred disinfection method for hydrophilic materials with good benefits: it uses less disinfectant solution and it can reduce the possibility of distortion after prolonged immersion. The British Dental Association recommends spraying only for hydrocolloids and polyethers.<sup>6,19,20</sup>

Therefore, both techniques have been shown to be effective in disinfecting impression material surfaces at different concentrations and applying times.<sup>16,21</sup>

### Dimensional stability

Dimensional stability is the ability of a material to maintain its three-dimensional size and shape over time under suitable conditions of humidity and temperature, which is essential to obtain accurate replicas of models and prostheses made from them.<sup>8</sup>

Disinfectants can produce a chemical or physical reaction with impression materials which could be dimensionally affected.<sup>10</sup> Therefore, an impression material disinfectant must meet two requirements: be an effective antimicrobial agent and preserve the

dimensional stability and surface details of both the impression and the resulting model to achieve greater clinical accuracy.<sup>8</sup>

One way to assess dimensional stability is through the time available for pouring. The longer the time available for pouring, the more stable the material is. The lower dimensional stability must be compensated with a quick pouring.<sup>15</sup>

Dimensional changes can occur in plaster models as a result of inherent characteristics of impression materials such as wettability, handling properties and viscosity. Other probable causes may be the thickness of the material between the oral tissues and the tray, impression fixing method, hydrophilicity of the material, loss of by-products, polymerization shrinkage, and thermal shrinkage due to temperature.<sup>11</sup>

According to ADA specifications, elastomeric impression materials should not produce more than 0.5% dimensional changes.<sup>9</sup>

## DISCUSSION

The impression disinfection process should be considered a routine procedure during dental practice. The disinfection methods recommended by the ADA are immersion and spraying. Although the latter is more frequently used in clinics and laboratories, most studies have evaluated the effect of immersion disinfection on dimensional changes in impression materials.<sup>22</sup>

There are also other disinfection methods, such as UV light, which has a powerful bactericidal effect since it reacts with the cell DNA, causing cell death.<sup>23</sup>

Disinfectants vary in their way of acting and their effectiveness. Sodium hypochlorite (NaOCl) is a top quality dental product due to its effectiveness and economy; it has a fast and broad spectrum antimicrobial action, since it has little or no negative effect on the plaster when used at lower concentrations and can improve surface details.<sup>9</sup>

In 2008, Melilli et al. studied the dimensional stability of polyether and addition silicone disinfected by immersion with glutaraldehyde and quaternary ammonium. They indicated that the effects of disinfection on both materials are not clinically relevant.<sup>18</sup>

In 2009 Amin et al. indicated that 0.5% sodium hypochlorite causes minimal dimensional changes in both the addition and condensation silicones, zinc oxide-eugenol (ZOE), and alginate, compared to the use of 0.2% chlorhexidine gluconate, 1% sodium hypochlorite, 2% glutaraldehyde, for 5 and 10 minutes.<sup>7</sup> The foregoing agrees with that found by

Bustos et al. who indicated that the number of bacteria retained in alginate was higher than in silicone, and that a 5-minute immersion with 0.5% sodium hypochlorite and 2% glutaraldehyde can effectively disinfect alginate and silicone impressions.<sup>16</sup>

Also within the use of aldehyde disinfectants, Rentzia et al. reported that disinfection with 0.55% Cidex<sup>®</sup> OPA (ortho-phthalaldehyde) and 0.5% sodium hypochlorite completely eliminated *Pseudomonas aeruginosa* after 30 s in Cidex<sup>®</sup> OPA and 120 s of NaOCl immersion, not affecting dimensional accuracy. They concluded that Cidex<sup>®</sup> OPA for 30 s turned out to be the most effective disinfection procedure.<sup>13</sup>

Regarding the use of the most recommended disinfectants in silicones, Ahila and Subramaniam pointed out that there are changes in dimensional stability and surface quality in models obtained from silicone impressions after disinfection for 10, 30 min and 1 hour in glutaraldehyde 2.45%, iodopovidone 5% and sodium hypochlorite 4%, but they are not significant. In addition, glutaraldehyde showed more accurate details than when using iodopovidone and sodium hypochlorite.<sup>17</sup>

These findings are consistent with Pal et al., who reported that complete disinfection of elastomeric impressions is achieved by immersion in 2% glutaraldehyde and 1% and 4% NaOCl, without deteriorating the surface details of type IV stone models. An important finding was that the impressions disinfected with 1% NaOCl showed better quality in terms of surface details reproduction.<sup>9</sup>

In 2015, Nassar et al. reported that the dimensional stability of addition and condensation silicones, after immersion in 2.5% glutaraldehyde, was within ANSI/ADA specification No. 19's acceptable limit, regardless of whether they were disinfected. Furthermore, the addition silicone underwent fewer dimensional changes than the condensation silicone.<sup>22</sup>

In 2016, Demajo et al. found that disinfection for addition silicone and alginate impressions, with the spray method using glutaraldehyde to eliminate all microbial forms on the surfaces of both materials is effective, without altering their dimensional stability. They also pointed out that alginate harbors three times more microorganisms than silicone impression material.<sup>24</sup>

Chidambaranathan et al. conducted a search on disinfection materials and methods from 1980 to 2016. They reported that for disinfection of impressions, in addition to glutaraldehyde, sodium hypochlorite, alcohols, chlorhexidine, ozonized water other methods such as sterilization by autoclaving and ultraviolet light, can be used. They concluded that impression

**Table 1: Main studies on dimensional changes after disinfecting impression materials.**

Author/year	Type	Conclusion
AlZain et al., 2020	Meta-analysis	Distortion and loss of impression surface detail should be avoided as they can adversely affect the fitting accuracy of the restorations. Therefore, better designed and standardized studies are needed to evaluate the effect of different commonly used disinfectants on properties of impression materials
Ulgey et al., 2020	<i>In vitro</i>	Immersion of alginate impressions in an ammonium-based disinfectant for 15 minutes can provide favorable results with minimal distortion compared to those disinfected for 30 minutes
Asopa et al., 2020	<i>In vitro</i>	There are dimensional changes within the recommended ranges for addition silicone impressions after autoclaving. Therefore, this impression material may be acceptable clinically for fabricating fixed dental prostheses (FPD). It is recommended pouring impressions after 24 hours to take advantage of the rebound phenomenon showed by this material
Nimonkar et al., 2019	<i>In vitro</i>	There are significant dimensional changes in polyvinylsiloxane samples disinfected with 2% glutaraldehyde and 1% sodium hypochlorite for 20 minutes. The impressions disinfected with 1% sodium hypochlorite showed greater discrepancy when compared 2% glutaraldehyde disinfected group
Azevedo et al., 2019	<i>In vitro</i>	Results indicate high antimicrobial efficiency without significant changes in three-dimensional shape of the addition silicone impressions. Hydrogen peroxide and sodium hypochlorite are easily accessible disinfectant solutions in dental environment. Additionally, hydrogen peroxide could be a valuable alternative for silicone impressions disinfection
AlZain et al., 2019	<i>In vitro</i>	There were statistically significant differences in wettability between addition, condensation and polyether silicone impressions. Improvements in wettability of 0.5% glutaraldehyde disinfected impression material surfaces were observed as measurement time increased
Ismail et al., 2017	<i>In vitro</i>	In complete edentulous, they evaluated the dimensional precision in impressions of alginate and ZOE paste, disinfected with 1% sodium hypochlorite, 2% glutaraldehyde, 1% sodium hypochlorite. They found that ZOE paste impressions disinfected with 1% sodium hypochlorite and 2% glutaraldehyde for 10 or 60 minutes did not affect dimensional stability, while for alginate impressions the immersion should only be 10 minutes so as not to affect the dimensional accuracy
Chidambaranathan et al., 2017	Literature review	Sterilization method is the most expensive, time consuming, and affects the dimensional stability of dental materials. Disinfection with chemical solutions is an alternative method for disinfecting hydrocolloid and silicone impression materials. Iodine is a recommended disinfectant for all types of impression materials
Demajo et al., 2016	<i>In vitro</i>	Glutaraldehyde-based disinfectants are effective in eliminating all microbial forms for both alginate and silicone impressions without modifying the dimensional stability, and alginate harbors three times more microorganisms than silicone
Nassar et al., 2015	<i>In vitro</i>	There is minimal effect on detail reproduction within the acceptable limit of ANSI/ADA specification No. 19 during disinfection by immersion with 2.5% glutaraldehyde and prolonged storage of up to 2 weeks. Furthermore, A-silicone undergoes fewer dimensional changes than condensation silicone
Pal et al., 2014	<i>In vitro</i>	There is a 100% reduction of microorganisms as a result of immersing the impressions in 2% glutaraldehyde and 1% and 4% NaOCl, without deteriorating the surface details when type IV stone plaster models were obtained. An important finding was that the impressions disinfected with 1% NaOCl had better quality in terms of surface details reproduction
Ahila et al., 2012	<i>In vitro</i>	There are trends for differences in dimensional stability and surface quality after 10 and 30 minutes and 1 hour for polyvinyl siloxane impressions, using glutaraldehyde 2.45%, povidone iodine 5% and sodium hypochlorite 4%, but they are not significant. The longer the exposure time to the disinfectant, the greater the change. Glutaraldehyde produced more accurate details than povidone iodine and sodium hypochlorite
Rentzia et al., 2011	<i>In vitro</i>	A significant increase in surface roughness was observed with increasing immersion time for the «rough» surface. Complete elimination of viable <i>Pseudomonas aeruginosa</i> cells from alginate discs was obtained after 30 and 120 s immersion in Cidex OPA <sup>®</sup> and NaOCl, respectively
Bustos et al., 2010	<i>In vitro</i>	Immersion for 5 minutes can successfully disinfect both materials and reducing the immersion time can also minimize changes in physical properties such as dimensional stability and surface integrity
Amin et al., 2009	<i>In vitro</i>	Disinfectants such as 0.2% chlorhexidine gluconate, 1% sodium hypochlorite, 2% glutaraldehyde for 5 minutes and 0.5% sodium hypochlorite for 10 minutes, used in alginate and addition silicone impressions, gave as a result that these latter disinfected with all said products gave gypsum models with dimensions very similar to those of the standard matrix. Of all the disinfectants used, 0.5% sodium hypochlorite showed minimal dimensional changes in all of the impression materials
Melilli et al., 2008	<i>In vitro</i>	Immersion disinfection procedures using two solutions (glutaraldehyde and quaternary ammonium) are not clinically relevant in dimensional stability of polyether and addition silicone

sterilization is more expensive, requires more time and creates instability in dental materials. The use of chemical solutions is an alternative method for materials such as silicone and alginate and iodophor disinfectants are recommended for all types of impression materials.<sup>4</sup>

In 2019 Ismail et al. concluded that impressions by ZOE paste disinfected with 1% sodium hypochlorite, 2% glutaraldehyde for 10 or 60 minutes did not affect dimensional stability. They emphasized that for alginate impressions, the immersion should only be 10 minutes so as not to affect the dimensional accuracy.<sup>10</sup>

However, in 2019, AlZain et al. recommended 0.5% glutaraldehyde spray disinfection on elastomeric impressions. The polyether showed better wettability than vinyl polysiloxane and the wettability of the impression materials improves after 10 minutes.<sup>19</sup>

Among the other disinfection alternatives, Azevedo et al. pointed out that there is high antimicrobial efficiency without significant changes in the three-dimensional shape of the addition silicone impressions, using hydrogen peroxide at 3%, commercial disinfectant MD520 (Durr) and sodium hypochlorite 1% and 5.25%. Furthermore, hydrogen peroxide is the least explored disinfectant and could be a worth alternative for disinfecting silicone impressions.<sup>8</sup>

In 2019, Nimonkar et al. reported significant dimensional changes in polyvinylsiloxane samples disinfected by 2% glutaraldehyde and 1% sodium hypochlorite for 20 min. The impressions disinfected by 1% sodium hypochlorite showed more dimensional discrepancies when compared to 2% glutaraldehyde disinfected group.<sup>23</sup>

Among the most frequent types of dimensional changes, in 2020, Asopa et al. found that the linear dimensional changes of addition silicone after autoclaving are within the recommended ranges when compared to the use of glutaraldehyde. They recommended pouring impressions after 24 hours taking in account the rebound phenomenon showed by this material.<sup>25</sup>

In 2020, Ulgey et al. conducted a recent literature review regarding the influence of time on the immersion method for alginates. They reported that the immersion of impressions with alginate in an ammonium-based disinfectant for 15 minutes can provide favorable results, which would allow to obtain impressions with minimally distorted dimensions compared to those disinfected for 30 minutes.<sup>26</sup>

In a recent systematic review and meta-analysis by AlZain et al. in 2020, they analyzed disinfection methods and materials and their effect on impression materials properties. Some studies reported

significant changes in the properties of impression materials, others reported no significant changes. They concluded that better designed *in vitro* studies are needed to evaluate the effect of different disinfectants.<sup>27</sup>

Impression taking is an important procedure in prosthetic fabrication. The impressions carry different microorganisms when they come in contact with saliva and blood. After disinfection it is important that impressions remain accurate and stable when reproducing the oral structures.

As it has been seen, there are several methods to disinfect impression materials, such as immersion, spraying, the use of UV light or autoclave sterilization. Many studies indicate that there are impression materials susceptible to a certain type of disinfectant and they alter the dimensional stability of the impressions, but they are no significant. Several authors recommend the clinician to take care when selecting the type of disinfection and the impressions exposure time (*Table 1*).

## CONCLUSIONS

1. Once the impressions are removed from the oral cavity, they must be disinfected before pouring, thus avoid cross-infection.
2. The most used disinfection methods are immersion and spraying.
3. The most widely used and easily accessible disinfectant solutions are 2% glutaraldehyde and 0.5% and 1% sodium hypochlorite.
4. The impressions made with alginate can be disinfected using 2% glutaraldehyde solutions or 0.5% sodium hypochlorite, guaranteeing the inhibition of bacteria in just 5 minutes, without altering their dimensional stability. Addition or condensation silicone impressions can be disinfected with 2% glutaraldehyde or 1% sodium hypochlorite for no more than 10 minutes, ensuring the elimination of all microbial forms on the impression surfaces, without altering their dimensional stability.

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