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Influence of Hypochlorous acid on Dimensional change, reproduction of details and compatibility with gypsum products of Addition Silicon Impression Material

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Abstract

Background: Patient saliva, plaque, or even blood can contaminate dental impressions. the disinfecting impression materials with disinfectants can help prevent contamination. However, these chemicals could alter the dimensional stability, reproduction of details and compatibility with gypsum products.

Aim: This research aimed to showed how the dimensional change, reproduction of details and compatibility with gypsum products of the Addition Silicon impression material (PVS) affected after it was immersed in to two different disinfectants (5.25% sodium hypochlorite NaOCl for ten minutes and 200 ppm hypochlorous acid HOCL for 15 minutes).

Methods: sixty PVS samples (Express STD, 3MESPE, USA). were splited into three test groups, each group of ten samples for each group test. The samples were prepared using a ring mould with the thirty mm diameter and a three mm wall thickness samples were immersion in two disinfection solutions: NaOCL at 5.25% and HOCL at 200 ppm. The group serving as the control received no disinfection. The dimensional change and compatibility with gypsum products of the samples was measured by using a digital microscope, while the reproduction of details was measured by inspected visually without magnification.

Results: The dimensional change, reproduction of details and compatibility with gypsum products of the PVS non-significantly differ from those of a control group ($P>0.05$).

Conclusion: Within a limitation of this study, PVS can be disinfected more effectively by being immersed in 200 ppm HOCL for 15 minutes while maintaining its dimensional stability, reproduce details, and compatibility with gypsum materials.

Keywords: Addition Silicon, Hypochlorous acid, Dimensional stability, Compatibility with gypsum products, Dental impression disinfectant.

Introduction

Dental impressions are a critical step in prosthetic dentistry (Farhan and Fatalla, 2021). The dental impression may serve as a vehicle for fungal and bacterial transmission. The risk of cross-contamination is low in a healthy patient, but in a patient with a debilitating illness or weakened immune system, the risk of cross-contamination is considerable and poses a major hazard if proper precautions are not taken. Thus, a technique that prevents cross-infection without altering the dimensional stability, reproduction of details and compatibility with gypsum products of the impression is required (Abass and Ibrahim, 2012). Because of its many benefits, elastomeric impressions are often used. The most common of these materials is PVC. They continually come into contact with human saliva and blood, spreading bacteria to the cast. The disinfection process should be comprehensive enough to preserve the integrity of the impression's size and finish. Despite the statements of some researchers that immersion disinfectants have no effect on polyvinyl siloxane, other has discovered that this immersion reduces the dimensional change of these impressions. The American Dental Association (ADA) suggests a maximum immersion time of 30 minutes for silicon impression materials (Block and Rowan, 2020). Numerous studies have focused on removing bacteria with various disinfection solutions without altering these impression and cast properties (Abass, 2009).

The ADA Council on Dental Materials recommended immersion disinfectant for additional silicone and spray disinfectant for irreversible hydrocolloid.

Among the most commonly employed disinfectants are NaOCl, chlorhexidine, alcohol, glutaraldehyde, and H2O2. Since there isn't a disinfectant that "fits all" for impression materials, It is vital to use a chemical disinfectant with potent antibacterial capabilities for impression materials. that doesn't change the surface properties of impression materials (Hardan et al., 2022). A disinfectant must eradicate bacteria while maintaining the impression material and gypsum cast accurate. This is crucial if you want a final product that fits and functions properly. Different viewpoints exist regarding whether the disinfection process alters the impression or makes it worse (Naumovski and Kapushevska, 2017).

All species contain hypochlorous acid (HOCl), which is toxic to a wide variety of bacteria and viruses. By means of respiratory burst nicotinamide adeni Unsaturated lipids in the membrane are where HOCL binds most tightly, weakening cellular integrity. The most common type of HOCL occurs between pH values of 3 and 6, and its bactericidal effects are greatest in this range. Due to its widespread use around the globe, Environmental Protection Agency and Centers for Disease Control and Prevention (EPA & CDC) of the United States consider HOCL to be an extremely potent disinfectant. A number of bacteria and viruses can be quickly and effectively eliminated by this straightforward chemical mixture (Mikaeel and Namuq, 2019).

Sodium hypochlorite is a high-level disinfectant, and numerous research indicate that it is used to sanitize silicone impressions. According to to ADA of infection control (Shetty et al., 20113). The optimal period for disinfection that does not influence the qualities of impression material is 10 minutes, hence it was utilized as the positive control in this work.

The null hypothesis (H0) was immersion of the addition silicon impression material in 5.25% Sodium hypochlorite or 200ppm hypochlorous acid, possessed no influence on the dimension stability, reproduction of details and compatibility with gypsum products.

Material and Method

1-Test Pattern Preparation

According to international standard ISO 4823 (Bock et al., 2008). Amodified test block was created by CAD/CAM (Figure 1). Ruled block, mold, and metal riser are the three parts that make up the test block. The top surface of the cylindrical ruled block had a step that was 29.97 mm in diameter and 3 mm high. The test block was score with 3 horizontal lines (A, B & C) and 2 vertical

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lines (D.E. & DE') using CAD/CAM on the impression surface. a distance between 2 horizontal lines was 2.5 millimeters, whereas the space between any two vertically adjacent lines was 25 millimeters. A, B, C, DE, and DE' all have depths of 50 micrometers, 25 depths of 50 micrometers, 75 depths of 50 micrometers, and 75 depths of 50 micrometers, respectively. There is a 90° included angle on each line. The intersection of the vertical lines on line A was labeled X and X', on line B as Y and Y', and on line C as Z and Z',. The step of the rule block fits the test block ring. Its height is six millimeters, and its inner and outer diameters are each thirty millimeters. The impression material was held in the molded ring by means of a tray. The impression was extracted from the mold without any obvious damage using a mold riser with a diameter of 29.97 millimeters and a height of three millimeters (Mahalakshmi et al., 2019).

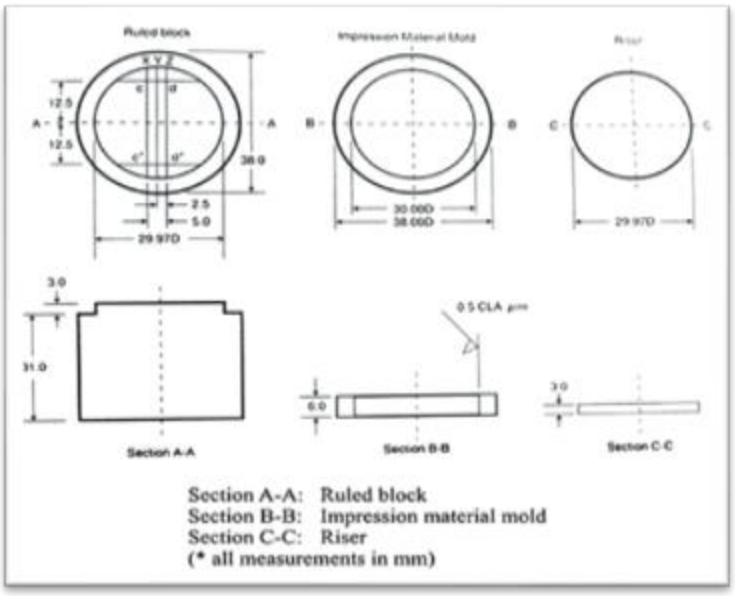

Figure (1): Test block for test dimensional stability, reproduction of details and compatibility with gypsum products of PVS sample

Specimens preparation

An auto-mixing impression gun was used to create impressions in order to obtain a homogenous combination. To apply the impression material to the test block's impression surface, the mixing tip had an intraoral tip attached to it. After being syringed over the test surface of the test block, Both impression types were pressed into the test surface in a zigzag manner (Mahalakshmi et al., 2019). A butty impression material was poured into the mold to give it a even thickness of 3 millimeters. A thin polyethylene sheet (D.P.I ,Indian) and subsequently a flat, hard metal plate were used to cover the mold. 1000 g of pressure was applied to the plate as it was pressed against the mold, which was enough to force the additional material out. The mould and test block were disassembled after the impression had time to set. Corresponding to ADA Specification No. 19 for elastomer impression materials, the riser was utilized to gently force the impression out of the mold.

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The final test sample was collected (Figure 2). 60 impression test samples were created as a result, and they were stored in a tidy, airtight polypropylene container (Mahalakshmi et al., 2019).

Immersion disinfection

A control group did not receive any treatment while the 200 ppm HOCL group immersed their samples for 15 minutes and the NaOCL group for 10 minutes. The samples from each group were cleaned with running water for 15 sec. prior to testing, and they were then dried with triple syringe.

Evaluation of liner Dimensional change:

liner Dimensional change was determined using the international standard ISO 4823 protocol (Bock et al., 2008). the length of the modified test block's middle horizontal line compared to the same line in the impression. The measurement was made at the points where the two vertical lines intersected. After its application is set up on the computer, the entire system is built for the monitor image. The digital microscope (figure 3) has a computerized magnifier and lenses as well as a CCD camera that can output a digital image to a monitor through a USB connection. The camera's plane of view was 10 cm away from the impression, and this digital microscope included a metal clamp to suspend it at a fixed distance from the items to be inspected (Ring Lite, 2012).

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Each impression image's middle horizontal line was measured with a 300X zoom and a digital lens microscope with 0.001 mm accuracy (Soft Imaging System, 2013).

Each image was calibrated against the known length of the middle line of the mould in the image before any measurements were made. The beginning and end lines of the measurement from the inner side of the two horizontal lines of the test impression were determined using a ruler with accurate calibration that was placed close to the impression.

The horizontal line impression was measured three times to a precision of 0.01 mm to account for assessor accuracy. Directly from the image of the impression or the cast, two operators employed a computerized Dino-Lite microscope with digital calipers (C.D.C.) to measure the distance between any two given points in our lines. The distance was measured in millimeters (Amin et al., 2012).

The cross lines were measured. Each impression received three readings: "A," "B," and "C." The following formula was used to determine the dimensional change from the mean of each impression's readings: (L - L'/ L) X 100

where

L represents the mold's dimension

L' represents the experimental impression material's dimension (Nallamuthu et al., 2006).

Evaluation of Reproduction of Details:

Accepted impressions were those that met ADA specification number 19 for reproduction of detail, reproducing the whole 75 m depth line of the test impression without interruption. Impressions were visually examined without magnification, and two operators performed this to obtain inter and intra calibrations. According to the following scoring system (Morrow et al., 1971):

- scoring (I) Well-defined, sharp detail, and continuous line.
- scoring (II) Continuous line but with some loss of sharpness.
- scoring (III) Poor detail or loss of line continuity.
- scoring (IV) wholly or marginally not discernible line.

Evaluation Compatibility With the Gypsum Products

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The dental stone was mixed according the manufacturer's instructions. (w/v 100g/25ml water) with a vacuum stone mixer (Germany) for 40 sec at 500 rpm, then The dental stone was poured into the gypsum mold while it was on a vibrator for 30 seconds. After 15 minutes, it was taken out of the mold and scored according to the following system (Morrow et al., 1971):

- scoring (I) Well-defined, sharp detail, and continuous line.
- scoring (II) Continuous line but with some loss of sharpness.
- scoring (III) Poor detail or loss of line continuity.
- scoring (IV) wholly or marginally not discernible line.

The evaluation of the Compatibility with the gypsum products according to ADA specification number 19 was carried out by one operator. The casts were looked at under a light microscope with a magnification of X10, and the above scoring and rating values of one to four were used to judge how well the details were copied. For grading purposes, both the 75 micrometer and 50 micrometer depth lines were measured for test impressions (Al-Omari et al., 1998).

Ethical approval:

This study does not include animals or human volunteers and deals with material only.

Statistical analysis:

Shapiro Wilk test and Levene test for the normality and homogeneity ANOVA (one-way analysis of variance) test was used to evaluate the significance of difference among the mean values of more than two groups, then Tukey LSD multiple comparisons test if the difference was statistically significant to examine the difference between every 2 groups after ANOVA.

Results and Discussion

Table 1. shows the average Dimensional change measurement and the standard deviation. There were no significant differences between the dimensional changes values of samples treated with various chemical disinfectants ($p>0.05$). The average and standard deviation of the readings for the gypsum product compatibility and reproduction of details are shown in Table 2. No significant differences ($p>0.05$) were discovered when comparing reproduction of details and compatibility with gypsum products values among samples treated with various chemical disinfectants.

Table (1): Mean and standard deviation for the Dimensional Change of addition silicon impression materials immerged to disinfectants.

Groups	N	Mean	SD	p-value
Control	10	.611	.7880	**.714**
5.25% NAOCL	10	.511	.9360	
200ppm HOCL	10	.661	.7200	

Groups	N	Mean	SD	P-value
Control	**10**	.00000	1.0000	**1.000**
5.25% NAOCL	**10**	.00000	1.0000	
200ppm HOCL	**10**	.00000	1.0000	

Table (2): Mean and standard deviation SD for the reproduction of details and compatibility with gypsum products of addition silicon impression materials immerged to disinfectants.

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Numerous dental impressions are sent to laboratories without being properly disinfected; part of these impressions contain food and blood contaminants. According to studies, harmful microorganisms are present in 67% of all dental impressions, crowns, dentures, wax, and other materials sent from laboratories (Hussian and Jassim, 2015).

There have been studies on the immersion of elastomer impression material with various disinfection solutions to investigate its effect on the physical properties of impression material, so the present study used hypochlorous acid as a new disinfection solution to the immersion of additional silicon impression material because it has several advantages, such as disinfection of the impressions and casts with a minimum adverse effect on the essential properties of addition silicon impression material.

The null hypothesis was accepted for the dimensional change test. Polyvinyl siloxane (PVS) is the most commonly studied material after disinfection due to its desirable handling properties and excellent physical properties, including greater dimensional stability, precision, higher tear resistance, and better detail reproduction. Elastomers have higher extensibility, excellent elasticity after large deformation, great viscoelastic properties, and better detail reproduction. However, silicones have these properties exhibit the lowest shrinkage after setting and the greatest dimensional change of any dental impression material (Amin et al., 2012).

While PVS is hydrophobic by nature; however, this material includes surfactants that enhance its ability to replicate details in a high-humidity environment. The presence of these agents upgrades the compatibility of hydrophilic PVS with water; the disinfectant solutions used in this research (5.25% sodium hypochlorite and hypochlorous acid disinfection) were chosen due to their widespread effects in the reduction of potential pathogens on impression surfaces (Vianna wt al., 2004) (McReynolds, 2018). The ADA recommends carefully cleaning impressions to remove any adhering saliva or blood, then immersing them in suitable disinfection solutions (Bhat et al., 2007). To maintain the accuracy of the impressions, they are usually exposed to disinfectants for no more than 10-15 minutes (Abdelhameed et al., 2022). The disinfectant solutions are considered appropriate if they do not affect the dimensional change of the utilized impression materials (Chidambaranathan and Balasubramanium, 2019). Furthermore, silicone did not expand significantly after being disinfected by immersing it in various chemicals for 10 minutes. Moreover, insignificant dimensional changes were found when additional silicone impression materials were disinfected for ten minutes (Ahila and Thulasingam, 2014).

Previous research has shown that a 10-minute immersion in sodium hypochlorite can effectively disinfect PVS impressions (Duseja wt al., 2014) (Atabek et al., 2009). Hypochlorous acid has been investigated as an antimicrobial efficacy for the disinfection of different materials and proved to be appropriately effective (McReynolds, 2018) (Jasim and Abass, 2022). The observed effect of hypochlorous acid on the physical properties of PVS impressions is almost lacking. Consequently, the present study was conducted to assess the potential effect of the freshly prepared hypochlorous acid on physical properties and PVS impressions.

In this study, there was a non-significant difference between the control group and the NaOCl group. Also, the non-significant difference between the control group and the HOCl group and this result was in agreement (Duseja wt al., 2014) (Jasim and Abass, 2022)

On the other hand, dimensional stability test results disagree with (Abdelhameed et al., 2022) (Sinobad et al., 2014). This disagreement may be due to using different disinfection solutions and test measurements.

Surface detail reproduction and compatibility with the gypsum products were accepted as the null hypothesis. Previous research has demonstrated that a 10-minute immersion in

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5.25% sodium hypochlorite can effectively disinfect additional silicon impressions (Bhat et al., 2007) (Duseja wt al., 2014) (Atabek et al., 2009). When used for removable PMMA dental prostheses, hypochlorous acid has been researched as an effective antimicrobial efficacy by McReynolds in 2018. Hypochlorous acid has a limited impact on the reproduction of surface detail and compatibility with PVS impressions' gypsum products. In order to determine how chemical disinfectants, specifically freshly prepared hypochlorous acid (200 ppm) and 5.25% sodium hypochlorite, affect the reproduction of surface detail and compatibility with PVS impressions' gypsum products, the current in vitro study was carried out.

According to The ADA Specification No. 19, the test samples' surface reproduction of details was assessed. If the cross line with a depth of 25 µm was reproduced continuously along its full length in at least eight of ten prepared specimens, the replication was regarded acceptable (score 1). The criteria mentioned above were evaluated as specified for elastomeric impression, Reproduction of this fine line was encouraged for elastomer impression materials because they can reproduce fine details better than hydrocolloid impression materials (Mahalakshmi et al., 2019).

In the current study, the surface detail reproduction of the PVS impression material and compatibility with the gypsum products were not affected by immersion hypochlorous acid (200 ppm) and sodium hypochlorite (5.25%); this result was in agreement with (Mahalakshmi et al., 2019)(kadhim and Abass, 2022) (Vadapalli et al., 2016).

In contrast, the reproduction of surface details of the PVS impression material and its compatibility with gypsum products did not meet the standards (Walker et al., 2005). This could be attributable to the enhanced hydrophilicity of PVS impression materials.

When the compatibility of gypsum was tested using the modified ADA specification no. 19, the reproduction of surface detail before and after immersion was not statistically significant.

Kumari et al.looked at how well gypsum worked with five different silicone impression materials. They came to the conclusion (Hoods-Moonsammy et al., 2014). that not all of the addition silicone impression materials they tested worked well with the different type IV gypsum products used in the study. These results didn't match with the present study, which could be because the present study used different types of elastomers and die stones (Menees et al., 2015).

More research needs to be done on the different properties of elastomeric impression materials and how well they work with different gypsum products.

Conclusion

Based on the study's parameters, it was determined that ten minutes of immersion disinfection in 5.25 percent sodium hypochlorite was safe, and that 200 parts per million of HOCL showed promise as an effective disinfection solution that would not affect the dimensional change, reproduction of details, or compatibility with gypsum products.

Conflict of interest: The authors declare no conflict of interest.

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الخلاصه

يمكن لعاب المريض أوالدم أن يلوث انطباعات الأسنان. يمكن أن تساعد المواد المطهرة في تقليل التلوث. ومع ذلك ، يمكن لهذه المواد الكيميائية أن تغير ثبات الأبعاد ، وإعادة إنتاج التفاصيل والتوافق مع منتجات الجبس.

الهدف: يهدف هذا البحث إلى إظهار كيفية تغير الأبعاد ، وإعادة إنتاج التفاصيل والتوافق مع منتجات الجبس لمادة السيليكون بعد غمرها في مطهرين مختلفين

لا يختلف تغيير الأبعاد ، استنساخ التفاصيل والتوافق مع منتجات الجبس في السيليكون بشكل كبير عن تلك الخاصة بمجموعة التحكم.

الخلاصة :يمكن تطهير مادة السيليكون بشكل أكثر فعالية من خلال غمرها في 200 جزء في المليون بماده الهايبوكلورس لمدة 15 دقيقة

Abstract

Patient saliva and blood can contaminate dental impressions. The disinfecting impression materials can help prevent contamination. However, these chemicals could alter the dimensional stability, reproduction of details and compatibility with gypsum products.

Aim: This research aimed to showed how the dimensional change, reproduction of details and compatibility with gypsum products of the Addition Silicon impression material (PVS) affected after it was immersed in to two different disinfectants

Results: The dimensional change, reproduction of details and compatibility with gypsum products of the PVS non-significantly differ from those of a control group using immersing in 200 ppm HOCL for 15 minutes.

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