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ORIGINAL ARTICLE

3D cone-beam C.T. imaging used to determine the effect of disinfection protocols on the dimensional stability of full arch impressions

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Abstract *Aim:* This study aimed to investigate the dimensional stability of irreversible hydrocolloid and polyvinylsiloxane (P.V.S.) impressions after exposure to four commercial disinfectants using cone-beam computed tomography (CBCT).

Materials and Methods: Two different impression materials were tested: irreversible hydrocolloid and P.V.S. Four disinfection solutions were applied: BirexSE, Opti-Cide3, COEfect MinuteSpray, and CaviCide Spray. Distilled water was used as a control group. Each solution remained in contact with the impression for 5 min. Additional contact time of 5 min compromises time for scanning. The materials were evaluated for dimensional stability after the impression of a maxillary complete edentulous template via CBCT before and after being in contact with the disinfectant agents. Measurements were assessed on the digital models from A-B, B-C, and C-A points. Paired analyses (Wilcoxon Signed Rank test or paired Student's *t*-test) were used to analyze each measurement before and after the contact with the disinfectant agents. The variance for each measurement was also analyzed via a one-way analysis of variance or Kruskal-Wallis.

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Results: Overall, there were no statistical differences among the points measurements in the irreversible hydrocolloid or P.V.S. between initial and final assessments ($p > 0.05$). The used disinfectant agents in this study did not influence each measurement's variation on irreversible hydrocolloid or P.V.S. ($p > 0.05$). All agents showed an effect on the dimensional stability of both impression materials. The differences in the three dimensions ranged between 0.34 and 1.54%.

Conclusion: Within 10 min of removing the impression from the master cast, is study's findings indicated that the four commercially available disinfectants did not influence the dimensional stability of irreversible hydrocolloid or P.V.S. Further studies should be performed to elucidate the antimicrobial effect of these solutions applied as a spray on the surface of irreversible hydrocolloid and P.V.S. impressions.

1. Introduction

Dental impression materials can be a potential source of contamination from the patient's saliva, dental plaque, and blood (Chidambaranathan and Balasubramanium, 2019; Choi et al., 2014). The cross-contamination from the impression, casts, or prostheses can occur between patients or dental personnel (Estafanous et al., 2012; Owen and Goolam, 1993).

A wide variety of microorganisms in the materials' surface may lead to opportunistic infections, especially in immunocompromised persons (Demajo et al., 2016; Egusa et al., 2008; A.D.A., 1996). These microorganisms may even remain on gypsum cast after the contact with impressions (Ivanovski et al., 1995). Therefore, the contaminated impressions should not leave the dental office without proper disinfection. However, with disinfection procedures, removing microorganisms from materials' surfaces is essential without jeopardizing their stability and quality (Punj et al., 2017; Rodrigues et al., 2012).

The current guidelines of the American Dental Association (A.D.A.) recommend washing the impressions to remove attached saliva and blood, followed by their immersion in disinfecting solutions (A.D.A., 1996). To maintain their accuracy, the maximum exposure time of the impressions to the disinfectants is usually 10–15 min (Soganci et al., 2018). The ideal disinfectant solutions should not induce significant dimensional changes to the impression materials (Chidambaranathan and Balasubramanium, 2019; Punj et al., 2017).

According to A.D.A. Specification No. 19 (ISO 4823, 2007), for an elastomeric impression to be classified as dimensionally accurate over time, the material should exhibit no more than 0.5% dimensional change upon setting. (Chidambaranathan and Balasubramanium, 2019; Punj et al., 2017). Therefore, to ensure reliable clinical outcomes, it is essential to investigate the physical properties of the impression materials after disinfection (Demajo et al., 2016; Rodrigues et al., 2012).

Several methods have been suggested to disinfect impression materials, including the use of chemical solutions or other techniques such as ultraviolet-wavelength or microwave radiations (Abdelaziz et al., 2004; Larsen et al., 2000; Nimonkar et al., 2019; Samra and Bhide, 2018). There is a variety of disinfection solutions that can be used to disinfect impressions, such as sodium hypochlorite, quaternary ammonium compounds, iodophor, and glutaraldehyde (AlZain, 2019; Chidambaranathan and Balasubramanium, 2019; Punj et al., 2017). Since there is a wide range of disinfectant solutions and protocols available and even lack compatibility (Chidambaranathan and Balasubramanium, 2019), there is no universal protocol to disinfect impressions.

Due to the widespread use of different chemical substances to assist in microorganisms' control, the effect of disinfectants on the properties of impression materials, mainly in their stability and precision, has been investigated (Lepe and Johnson, 1997; Rodrigues et al., 2012; Soganci et al., 2018). Dimensional stability is essential to achieve accurate models of patients (Martins et al., 2017). This property can be affected by the effects of syneresis or imbibition in impression materials. Dimensional stability can significantly vary according to physicochemical features expressed by the chosen material. Previous studies were conducted to investigate the dimensional stability of materials following chemical disinfection (Martins et al., 2017; Nimonkar et al., 2019; Rodrigues et al., 2012; Soganci et al., 2018). Irreversible hydrocolloids are the most widely studied materials after disinfection due to their low cost and ease of use (Rodrigues et al., 2012) and polyvinyl siloxane (P.V.S.) due to higher tear resistance, better reproduction of details, and greater dimensional stability (Hulme et al., 2014).

The American Dental Association (A.D.A.) reported specific guidelines to examine the dimensional stability of impression materials in an area of fewer than five millimeters using cylindrical metal block and then estimate the measurement over two horizontal coordinates (ISO 4823, 2007). This metrical method is the most widely used. However, it is not possible to observe the tridimensional results. Therefore, other studies have used different techniques to quantify the dimensional changes in impression materials such as 3D laser scanner (Basaki et al., 2017), laser scan micrometer (Hiraguchi et al., 2013), and digital caliper (Amin et al., 2009).

Cone-beam computed tomography (CBCT) has shown increased use in dentistry, including scanning impressions to abolish plaster pouring. Previous studies evaluated the CBCT scanning of impression materials, in which the majority of them sent the materials for scanning in laboratories and not via dental CBCT (Jiang et al., 2016). However, there is no evaluation of CBCT to analyze the dimensional stability of impression dental materials after disinfection procedures. This study aimed to investigate the dimensional stability of two commonly used impression materials (irreversible hydrocolloid and P.V.S.) after exposure to four commercially available disinfectants using digital assessment via CBCT. The disinfection solutions tested here differed in their composition, such as the presence or absence of quaternary ammonium compounds and

the presence of ethanolic-based solutions combined with other substances or not.

2. Materials and methods

2.1. Experimental design

The design of this in vitro study is illustrated in Fig. 1. Two different impression materials were tested: irreversible hydrocolloid and polyvinylsiloxane (P.V.S.). The composition and manufacturer of the impression materials are displayed in Table 1. Four disinfection solutions were applied: BirexSE, Opti-Cide3, COEfect MinuteSpray, and CaviCide Spray. Distilled water was used as a control group. The composition and manufacturer of the solutions tested are also shown in Table 1.

2.2. Preparation of impressions

Ten impression of irreversible hydrocolloid were made per group of disinfection solutions (n = 10), as well as another ten for P.V.S. to be in contact with the five disinfection solutions (n = 10). A maxillary complete edentulous template designed to mimic the natural anatomy (Elite, Rock Company, U.S.A.) was used in the study. The template had three metallic equidistant reference points with 2 mm height each one (Fig. 2a). The anterior reference point is located in the midline of the palate at the incisive papilla area. The other two reference points were in the maxillary tuberosity area and 5 mm away from the alveolar ridge's crest. The dimensional stability was assessed by measuring the distance between points: A to B, A to C, and B to C on the taken impressions.

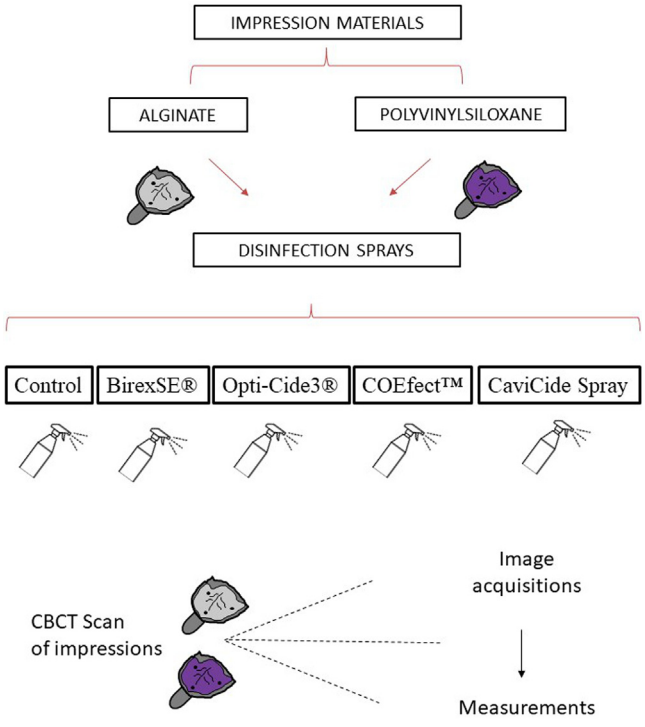

Fig. 1 Scheme of the study design.

Disposable trays (COE® Spacer, full arch, perforated, G.C. America Inc, Alsip, IL) were used to obtain 50 irreversible hydrocolloid impressions and 50 P.V.S. impressions (Fig. 2b). All procedures were performed with the same instruments, proportions, mixing time, and setting time for each type of impression material. C.O.E. tray adhesive (G.C. America Inc, Alsip, IL) and universal VPS adhesive (G.C. America Inc, Alsip, IL) were applied before irreversible hydrocolloid and P.V.S. impressions loading, respectively. The trays loaded with the impression materials were aligned perpendicular to the template for impression capture. After setting, the impressions were removed and washed under running water for 10 s to mimic the clinical condition (Soganci et al., 2018). The impressions were taken at room temperature. Each disinfectant was applied via spraying method, with ten puffs within 15 s. Each solution remained in contact with the impression for 5 min. Additional contact time of 5 min compromises time for scanning. Some products recommend three min-contact while the other one min-contact, we stabilized a 5 min contact for standardization propose. To keep the materials free from possible contamination, sterilized instruments, and personal protective equipment for handling were used.

2.3. 3-Dimensional stability assessment

The dimensional changes of the materials were obtained digitally via 3D imaging software using cone-beam computed tomography (CBCT). The impression materials were scanned via CBCT (Carestream 9300, Atlanta, GA, U.S.A.) using the following parameters: 80 kV, 2 mA, 0.2-mm^3 voxel size, and 102-mm field of view (Fig. 2c). All impressions were scanned within 2 min after removing them from the template. Measurements between the reference points on the impressions were made on the digital models from A-B, B-C, and C-A. Each solution remained in contact with the impression for 5 min. Additional contact time of 5 min compromises time for scanning.

The time for removing the impression from the template to the final scanning was determined to not be longer than 5 min for each sample. The digital file obtained with CBCT was reconstructed into 3D images. The 3D images were converted to the stereolithography format using a 3D imaging program (C.S. 9300C Select, Carestream Dental L.L.C., Atlanta, GA) with identical Hounsfield units (−175) for each image. Then, these images were transferred to DICOM viewing software CS Mesh viewer. CS Mesh Viewer is a program that allows us to view S.T.L. files, or PLY files. The images were imported into a 3D reverse engineering software program (Rapidform™2006; Inus, Seoul, Korea). The negative impression of the template's reference points was changed to positive in the images to produce the final digital model (Fig. 2d). The distance was measured before the disinfection with the sprays was recorded as M_1 and after the disinfection as M_2.

2.4. Statistical analysis

The data were analyzed via SigmaPlot software, version 12.0 (Systat Software, Inc., San Jose, CA, U.S.A.). Data distribution was evaluated using the Shapiro–Wilk test. The distance measurements A-B, B-C, and A-C, were compared before and after the procedures for each disinfectant for both impres-

Table 1 Description of the two impression materials and four disinfectant solutions used in the study.

Materials	Manufacturer	Composition (wt. %)	Presentation	Minimum contact time used in this study (disinfectant solutions)
COE ALGINATE™	GC America Inc, Alsip, IL	Kieselguhr, soda ash flux-calcined 50–70%, dipotassium hexafluorotitanate 1–5%, zinc oxide 1–5%, tetrasodium pyrophosphate 1–5%	One powder (5 lbs.) and 1 scoop.	Not applicable
Examix NDS	GC America Inc, Alsip, IL	Base: silicon dioxide, amorphous 25–50%; polyethylene glycol derivative** 5–10%; methyl hydrogen dimethylpolysiloxane 1–5% Catalyst: silicon dioxide, amorphous 3 Iron (III) oxide; Mixture of the substances (trade secret)	NDS Automix Cartridge with base and catalyst NDS Automix Cartridge Dispenser (1 unit) NDS Automix and Universal Mixing Cartridge Tips	Not applicable
BirexSE®	Biotrol, Earth City, MO	Isopropyl alcohol 5–10%; 2-Butoxyethanol 1–5%; Phosphoric acid 15–17%; 2-Phenylphenol 5–10%; 4-*tert*-Pentylphenol 5–10%; sulfonic acids, sodium salts, C14-16 alkane hydroxyl and C14-16 alkane 5–10%	Powder to be dissolved One 1/8 oz (3.70 ml) packet to each pre-measure quart (0.946L)	5 min
Opti-Cide3®	Micro-Scientific, LLC Gurnee, IL	Isopropyl alcohol 10–30% 2-Butoxyethanol1-5%	24 oz. trigger spray bottle	5 min
COEfect™ MinuteSpray	GC America Inc, Alsip, IL	Ethyl alcohol 60–80%	24 oz. trigger spray bottle	5 min
CaviCide Spray®	Metrex Research Corporation, Orange, CA	Isopropanol 10–20%; Butyl cellosolve 1–5%; Hyamine 0.1–1%	24 oz. trigger spray bottle	5 min

sion materials: irreversible hydrocolloid and P.V.S. via Wilcoxon Signed Rank test or paired Student's *t*-test. For irreversible hydrocolloid, distilled water and Cavicide measurements were treated via the Wilcoxon Signed Rank test, as well as Birex A-B and B-C, and G.C. Coeffect A-B and B-C. The other analyses were performed via the paired Student's *t*-test.

For P.V.S., Opticide measurements and Birex A-C were analyzed via paired Student's *t*-test. The other measurements were evaluated via the Wilcoxon Signed Rank test. One-way analysis of variance (ANOVA) or Kruskal-Wallis was used to compare the values of the difference between before and after procedures within each measurement (A-B, B-C, A-C) among the disinfectants. Indeed, for irreversible hydrocolloid, the measurement variation A-C, and for P.V.S. measurement variation A-B, ANOVA was applied. The other analyses were tested via Kruskal-Wallis. A significance level of 0.05 was considered for all tests.

3. Results

Fig. 3 displays the distance measurements A-B, B-C, and A-C values for the impressions performed with irreversible hydrocolloid. In the initial analysis, the values ranged from 21. 86 (±0.31) mm in the B-C measurement for distilled water to 25.55 (±1.20) mm in the A-C measurement for Opticide. In the final analysis, the values ranged from 21.86 (±0.15) mm in the B-C measurement for Cavicide to 25.45 (±1.17) mm in the A-C measurement for Opticide. Distilled water, and Birex groups showed statistical differences in the paired analysis when the initial and final measurements were compared ($p < 0.05$). The other disinfectant agents showed no statistical difference between initial and final values for any of the measurements ($p > 0.05$). Table 2 shows the mean and standard deviation values of measured variation for each distance (A-B, B-C, and A-C) in the irreversible hydrocolloid impressions. There was no statistical difference among the disinfectant agents within each measurement ($p > 0.05$).

Fig. 4 displays the values of the A-B, B-C, and A-C measurements for the impressions performed with P.V.S. In the initial analysis, the values ranged from 21.86 (±0.31) mm in the B-C measurement for distilled water to 25.47 (±0.82) mm in the A-C measurement for G.C. Coeffect. In the final analysis, the values ranged from 21.86 (±0.15) mm in the B-C measurement for Cavicide to 25.51 (±0.86) mm in the A-C measurement for G.C. Coeffect. The differences expressed in % errors observed within-group ranged from 0.65% to 0.34%, comparing initial to final measurements.

As well as occurred for irreversible hydrocolloid, the groups distilled water and Birex showed a statistical difference in the paired analysis between initial and final values ($p < 0.05$). The other groups of disinfectant agents showed no statistical difference in the paired analyses for any of the measurements ($p > 0.05$). Table 2 shows the mean and standard deviation values of measured variation for each distance (A-B, B-C, and A-C) in the impressions performed with P.V.S. There was no statistical difference among the disinfectant agents within each measurement ($p > 0.05$).

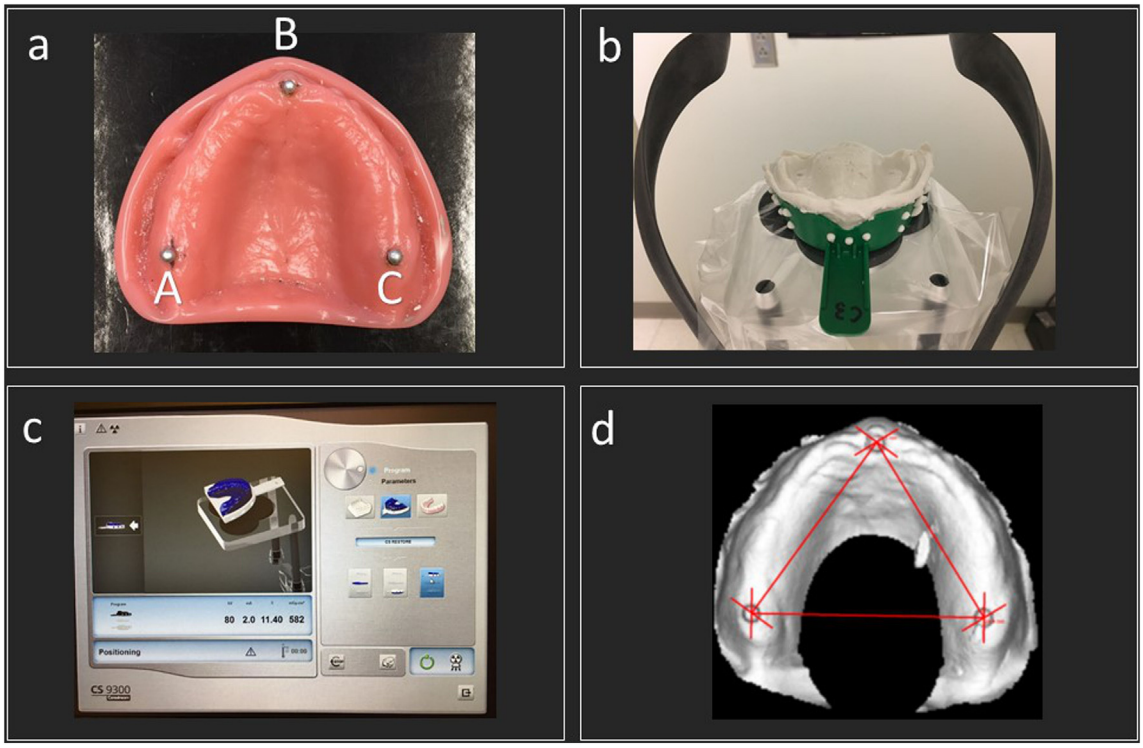

Fig. 2 Preparation of impressions and dimensional stability assessment. Image "a" displays the template used to prepare the impression, indicating that it had three metallic equidistant reference points with 2 mm height each one. Image "b" shows the disposable trays used to obtain the specimens. Image "c" illustrates an impression material been scanned via CBCT. Image "d" demonstrates that the negative impression of the reference points of the template was changed to positive in the images to produce the final digital model.

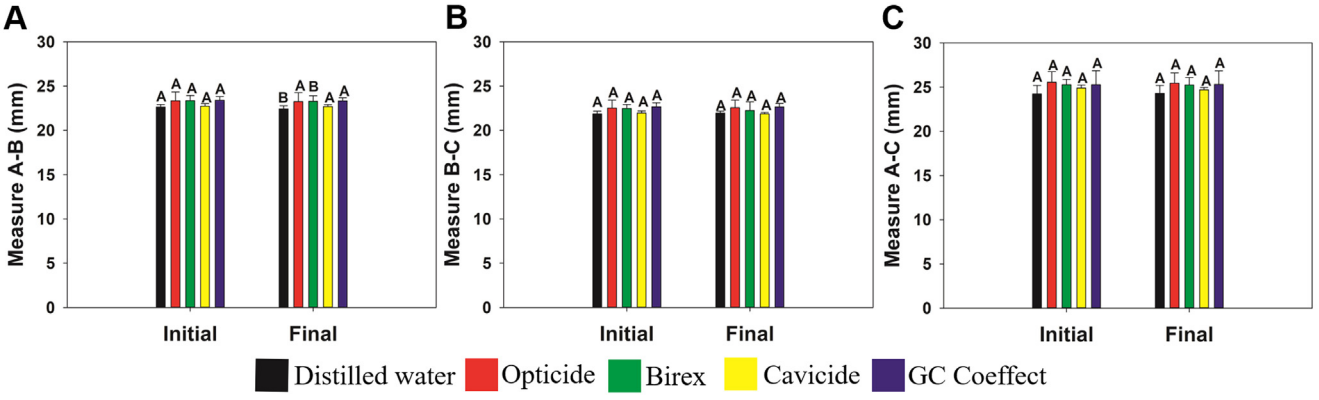

Fig. 3 Results of the A-B, B-C, and A-C measurement for the impressions performed with irreversible hydrocolloid. The results were acquired before (initial) and after (final) and disinfection procedure.

4. Discussion

In the current study, we used 3D cone-beam C.T. image to evaluate the effect of five different disinfectants on the dimensional stability of irreversible hydrocolloid and P.V.S impressions. Overall, the disinfectants did not affect the dimensions of the irreversible hydrocolloid or P.V.S. impressions. All the disinfected impressions made from irreversible hydrocolloid and elastomeric (P.V.S.) were found to maintain accuracy in both the anteroposterior and cross arch dimensions. These findings a agree with previous reports in the literature (Babiker et al., 2018; Johnson et al., 1998).

Accurate surface details, minimal distortion on removal, and excellent dimensional stability are the main features of a high-quality impression (Mahalakshmi et al., 2019). However, irreversible hydrocolloid and P.V.S. are both elastic materials with chemical setting mechanisms. Both materials are user-friendly. They are widely employed to produce study/diagnostic casts (irreversible hydrocolloids) and work-casts (silicone). The class of elastomers has greater extensibility, remarkable elastic recovery after deformation, excellent viscoelastic property, and better reproduction of details (those with lower viscosity reproduce 20 μm-line) in comparison to irreversible hydrocolloids (most reproduce 50 μm-line) (Schmidt et al.,

Table 2 Mean range variation of the measured values for each distance (A-B, B-C, and A-C) and the corresponding percentage of variation in the irreversible hydrocolloid impressions and the polyvinyl siloxane impressions.

Group	Measure variation A-B in mm (%)	Measure variation B-C mm (%)	Measure variation A-C in mm (%)
Irreversible hydrocolloid (Distilled water)	22.63–22.42 (0.64%) ^{A}	21.88–21.94 (0.34%) ^{A}	24.22–24.29 (0.04%) ^{A}
Irreversible hydrocolloid (Opticide)	23.35–23.25 (−0.15%) ^{A}	22.53–22.56 (0.34%) ^{A}	25.55–25.45 (−0.06%) ^{A}
Irreversible hydrocolloid (Birex)	23.36–23.29 (−0.65%) ^{A}	22.47–22.39 (-0.52%) ^{A}	25.28–25.25 (−0.53%) ^{A}
Irreversible hydrocolloid (Cavicide)	22.73–22.69 (−0.05%) ^{A}	21.95–21.86 (-0.34%) ^{A}	24.90–24.70 (−0.72%) ^{A}
Irreversible hydrocolloid (GC Coeffect)	23.41–23.33 (−0.33%) ^{A}	22.66–22.65 (0.02%) ^{A}	25.28–25.31 (−0.04%) ^{A}
Polyvinyl siloxane (Distilled water)	22.63–22.42 (−1.05%) ^{A}	21.86–21.94 (0.34%) ^{A}	24.25–24.34 (0.14%) ^{A}
Polyvinyl siloxane (Opticide)	23.45–23.33 (−0.20%) ^{A}	22.52–22.51 (0.14%) ^{A}	25.46–25.35 (−0.14%) ^{A}
Polyvinyl siloxane (Birex)	23.36–23.29 (−0.65%) ^{A}	22.47–22.35 (−0.52%) ^{A}	25.29–25.21 (−0.40%) ^{A}
Polyvinyl siloxane (Cavicide)	22.73–22.72 (−0.05%) ^{A}	21.95–21.86 (−0.34%) ^{A}	24.91–24.80 (−0.32%) ^{A}
Polyvinyl siloxane (GC Coeffect)	23.41–23.33 (−0.33%) ^{A}	22.66–22.67 (0.02%) ^{A}	25.47–25–51 (0.08%) ^{A}

Same capital letters in the same column indicate no statistical difference among groups within the same material (irreversible hydrocolloid or polyvinyl siloxane) in the same measure (A-B, B-C or A-C) ($p > 0.05$).

2018). However, it is not only due to these properties that silicones can be chosen, but silicones also display the lowest contraction overtime after setting and demonstrate the highest dimensional stability among all dental impression materials (Amin et al., 2009). Moreover, silicones are often required due to the advantage of producing more than one cast with the same impression or because the clinician needs more time for plaster (Babiker et al., 2018).

On the other hand, irreversible hydrocolloid has high susceptibility deformation, porosity, and syneresis or imbibition, depending on the storing environment (Hiraguchi et al., 2013). Despite the type of impression, the dimensions must not be compromised until pouring the casts; therefore, disinfection procedures should not affect their physical properties. For this reason, we scanned each sample of impression material within 10 min since the removal from the template, standardizing the method for both irreversible hydrocolloid and P.V.S. Measurements were recorded either from the impressions or the gypsum casts produced by the reference points. The distance measurements on the impression materials were advantageous for the present study to eliminate other factors that could influence the final casts' stability.

The vast literature available regarding disinfection solutions point out that glutaraldehyde is the first choice solution for the disinfection of impression materials, but alcohols had also been widely investigated (Chidambaranathan and Balasubramanium, 2019; Demajo et al., 2016; Martins et al., 2017; Pandita et al., 2013; Sofou et al., 2002). Here, different agents were tested against irreversible hydrocolloid and P.V.S. While distilled water was used as a control, four other disinfectant agents containing mainly alcohol were evaluated. Ethyl and isopropyl alcohol are disinfectants and antiseptics but do not have to sterilize properties (Demajo et al., 2016).

At a concentration of at least 70%, these materials have broad-spectrum antimicrobial action. Substantial elimination of bacteria, enveloped viruses, mycobacteria, and fungi were observed following the use of alcohol due to the denaturation of proteins and lipid structures in the cell membrane (Kampf, 2018). One of the tested solutions, Birex, is composed of alcohol, but it also contains quaternary ammonium compounds (Table 1). Quaternary ammonium compounds are indicated mainly for disinfection and cleaning of fixed surfaces and non-critical materials (Lee et al., 2019; Mena Silva et al., 2020). These compounds also act on the cell membrane of microorganisms and desaturate proteins. Generally, they are not widely indicated for disinfecting impression materials because they present better effects when there is friction on

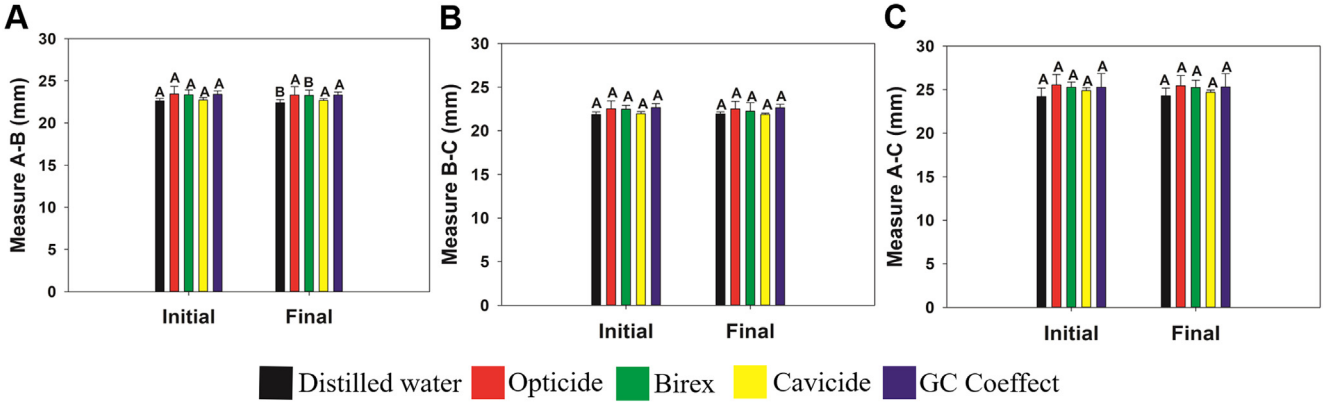

Fig. 4 Results of the A-B, B-C, and A-C measurement for the impressions performed with P.V.S. The results were acquired before (initial) and after (final) and disinfection procedure.

the surface to be disinfected associated with their application (Lee et al., 2019).

Interestingly, distilled water and Birex showed a statistical difference from the initial to the final measurements for irreversible hydrocolloid and P.V.S. in the A-B distance point. It is possible that with an increased period of exposure for both groups, a higher difference could also be observed for the other measurements (B-C and A-C). Birex is a more complex solution (Table 1), composed of acids and phenolic compounds, besides quaternary ammonium and alcohol. As a result, this solution presents a more aggressive behavior than the other three solutions, mainly alcohol only. Regarding distilled water, it might be considered that distilled water was able to be kept on the material surface for a more extended period in comparison to alcohol-containing disinfectants due to the differences in the vaporization pressure between water and alcohol. The disinfectants used in the present study are intended to be used for short contact time with the impression materials. Therefore, this slight, even significant difference may not be a concern due to the spray technique. Still, the immersion of impression materials into Birex and the antibacterial activity of all these disinfection solutions, should be investigated.

Conventional methods for assessing materials' dimensional stability are mainly two-dimensional (2D) by measuring the shrinkage or expansion between selected fixed points on the impression (Chen et al., 2004). Using 3D cone-beam to assess impression materials could be more accurate than the conventional methods, and the images can be acquired without affecting the impression properties (Karaaslan et al., 2018). The accuracy and reproducibility of CBCT have been investigated for 3D-implant site measurements and periodontal space measuring where the CBCT technique has shown accuracy of ± 0.1 mm. Similar findings were reported here where the accuracy of 0.06 mm for PVC and 0.09 for alginate was found (Al-Ekrish, 2012; Stimmelmayr et al., 2017). One key point in our design was the chosen control group. Previous studies have considered the effect of disinfectants in comparison with control groups that were stored in dry conditions, which usually mimics the clinical practice when the impressions may be conditioned on the bench. However, distilled or deionized water seems to be a reliable approach to compare the disinfectant agents due to their chemical and hydrophilic effects (Garcia et al., 2020). As a limitation, this study did not evaluate the antimicrobial effect of commercially available chemical agents. This study also could assess the dimensional changes with no solution to investigate if the changes would occur despite the used solutions.

Moreover, we did not analyze possible effects in gypsum casts. The differences here observed within-group represent–0.65–0.34%, comparing initial to final measurements. Since we observed only a few and small differences in the impressions, we would probably find a similar pattern in the casts. Further analyses in the gypsum casts could bring additional information about the solutions' effect in the final process. It is also worth saying that this study's results are dependent on the accuracy of the CBCT measurements.

Further studies should be performed to reveal if these chemicals could be effective in eradicating oral microorganisms. Moreover, other physical properties, such as recovery from deformation, compressive strength, and detail reproduction, could be analyzed. Within our limitation, all the disinfection solutions investigated have shown minimal impact on the dimensional stability of irreversible hydrocolloid and P.V.S. impressions.

5. Conclusions

This study's findings indicated that the dimensional stability of irreversible hydrocolloid and P.V.S. was maintained after contact with four different commercially available chemical agents. Each solution remained in contact with the impression for 5 min. Additional contact time of 5 min compromises time for scanning. These reported results are valid within 10 min of removal from the master cast as the percentage of dimensional changes before and after disinfection was between 0.34 and 1.54% in the two impression materials. Further studies should be performed to investigate the antimicrobial effect of these solutions applied as a spray on the surface of a contaminated irreversible hydrocolloid or P.V.S. impressions.

Ethical statement

This study did not involve the use of human subjects, living cells, or experimental animals.

Disclosure form

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