RSBO

ISSN:
Electronic version: 1984-5685
RSBO. 2018 Jul-Dec;15(2):77-83

Original Research Article

Linear dimensional stability of irreversible hydrocolloids with and without disinfection at different storage times

Lidia Olga Bach Pinheiro[1]
Alfonso Sanchez Ayala[1]
Marcos Cezar Pomini[1]
Vanessa Taborda da Cruz[1]
Ingrid Viel del Farias[1]
Adriana Postiglione Buhrer Samra[1]

Corresponding author:
Marcos Cezar Pomini
Departamento de Odontologia
Avenida Gal. Carlos Cavalcanti, n. 4.748 – Uvaranas
CEP 84030-900 – Ponta Grossa – Paraná – Brasil
E-mail: marcospomini@outlook.com

[1] State University of Ponta Grossa – Ponta Grossa – PR – Brazil.

Received for publication: March 6, 2018. Accepted for publication: August 28, 2018.

Keywords:
alginates; dimensional stability; storage; disinfection.

Abstract

Introduction: Irreversible hydrocolloids have been used in dental practice for decades and their pouring time has been suggested to be as short as possible; however the latest generation of alginates exhibit better properties, which could influence the fidelity of the casts. **Objective:** To evaluate the linear dimensional stability of stone casts obtained using two irreversible hydrocolloid brands (Cavex ColorChange and Jeltrate) after disinfection. **Material and methods:** Samples were divided into 16 groups (n = 10) according to brand, storage time and disinfection. Impressions were taken of a metallic master model made of stainless steel with two abutments. Cast models were obtained using type IV gypsum, after disinfection with sodium hypochlorite at 1% or without any disinfection followed by storage for four different times (immediate pouring, and after 24, 72 or 120 hours storage after obtaining the impressions) and the models were measured with a digital caliper. Data were submitted to ANOVA 3-way followed by Tukey's test ($\alpha < 0.05$). **Results:** A statistically significant difference was detected with Jeltrate Plus after 72 and 120 hours in storage (with and without disinfection), as well as Cavex without disinfection. Differences were found for Cavex with disinfection/24 hours storage, when compared to immediate

pouring ($P < 0.05$). The alginates presented similar behavior regarding disinfection for the same time ($P > 0.05$). **Conclusion:** Storage longer than 24 hours affects the fidelity of casts. Disinfection does not promote significant alteration at any of the experimental times with either material.

Introduction

Increasing awareness of infectious diseases such as hepatitis B, acquired immunodeficiency syndrome (AIDS), tuberculosis, herpes simplex and other potentially transmitted ailments has required health professionals to double check their behavior in order to prevent cross-contamination. The responsibility for cleaning and disinfecting dental impressions before dispatching to the dental laboratory lies solely with the dentist [2]. Among impression materials, alginates have a disadvantage regarding the disinfection procedure due to their ability to lose or incorporate water, which leads to dimensional alterations of the material.

Obtaining irreversible hydrocolloid impressions is one of the most common procedures performed in a dental office as part of treatment planning and fabrication of appliances [12], even though this material harbors three times more microorganisms than silicone impression material [5]. However, concerning the main causes of unsuccessful clinical results related to alginate, the phenomena of water absorption expansion (imbibition) and shrinkage due to loss of water through evaporation and syneresis, mainly due to factors such as storage conditions, might result in the production of inaccurate impressions [4].

The American Dental Association (ADA) [1] advocates that impressions must be washed in running water to remove debris, blood and saliva and then disinfected with chemical solutions that are compatible with the impression materials. Due to the hydrophilic nature of alginates, which is responsible for their higher retention of bacteria, disinfection must be carried out with a product that requires little time to complete the disinfection process [17].

Currently, there are extended-pour alginates that can keep their dimensional stability for 5 days until cast generation [14]. The possibility of storing impressions without consequent dimensional alterations would be an advantage of a material within the clinical setting, enabling the professional to conclude a procedure or send an impression to the laboratory in order to obtain the model, for example. However, the need for disinfection might alter this scenario when combined with late pouring.

Being aware of the importance and complexity of infectious disease prevention and knowing that dimensional fidelity and reproduction of anatomic details are important requirements for the impressions used to create gypsum models, this study aimed to evaluate the dimensional alterations of two commercial brands of irreversible hydrocolloids currently on the market. The hydrocolloid impressions were disinfected with sodium hypochlorite 1% after which we verified whether any alteration of their dimensional accuracy might occur and whether this alteration might vary with immediate or late pouring. Therefore, the null hypotheses tested were (1) no dimensional alteration of impressions would occur after different storage times and (2) disinfection would not promote dimensional alteration after different storage times.

Material and methods

A stainless steel matrix with two cylindrical elevations, designed to simulate two abutment teeth [9, 15] was used in this study (figure 1). The largest and smallest distances between abutments were measured using a digital caliper (Mitutoyo Absolute Digimatic Caliper, Kawasaki, Japan) [9] producing values of 24.05 mm and 15.93 mm, respectively. The smallest measurement between pins was chosen as the one to be followed. This matrix was used as a standard model, and 160 irreversible hydrocolloid impressions were obtained: 80 using Cavex ColorChange (Cavex Holland BV, Haarlem, Netherlands) and 80 using Jeltrate Plus (Dentsply Caulk, Milford, DE, USA).

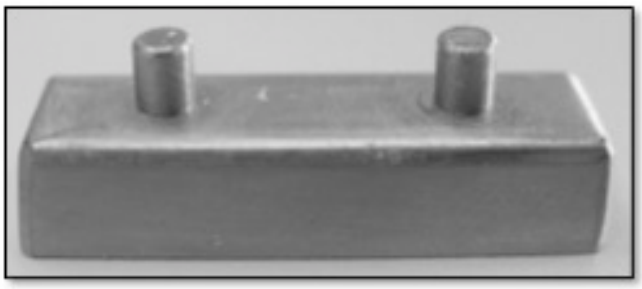

Figure 1 – Stainless steel matrix with two cylindrical elevations, designed to simulate two abutment teeth

The amounts of alginate powder recommended by the manufacturers were weighed with a high-precision scale (AW320, Shimadzu, São Paulo, Brazil) three times and the mean was used. The water was used at 23ºC and measured with a syringe for increased accuracy. For the Cavex ColorChange, 7.08 g powder was used for 15 ml water, while for Jeltrate Plus we used 7.37 g of powder for 15 ml water.

The irreversible hydrocolloids were mixed manually in a rubber bowl with a plastic spatula, always by the same operator and following the manufacturer's instructions. The mixing time was standardized at 30 seconds, and a homogeneous mass was obtained. The alginate was loaded onto a partial metallic perforated tray and seated on the metallic matrix. After 2 minutes, the impression tray was removed in a single movement parallel to the insertion axis, reducing the tendency to tear and minimizing interference in the material's elastic memory. All impressions were washed in running water for 30 seconds [8] simulating saliva removal and bacterial charge according to ADA specifications; however, only 80 of the impressions – 40 Cavex ColorChange and 40 Jeltrate Plus – were treated with the sodium hypochlorite 1% spray for 10 minutes. The remaining 80 were only washed in running water for 30 seconds [20, 22].

Each irreversible hydrocolloid brand was divided into eight groups according to storage time and whether or not disinfection with sodium hypochlorite 1% had been carried out: Cavex ColorChange (C) or Jeltrate Plus (J); storage time, immediate (0), 24 hours (1), 72 hours (3) and 120 hours (5); and with (c) or without (s) disinfection. This resulted in the following distribution: immediate pouring (C0c, C0s, J0c. J0s), pouring after 24 hours (C1c, C1s, J1c, J1s), after 72 hours (C3c, C3s, J3c, J3s), and after 120 hours (C5c, C5s, J5c, J5s). The 24, 72 and 120-hour storage impressions were individually placed into Ziplock-type plastic bags [9, 13] and stored in a plastic box, simulating the storage conditions of a clinical office. For each experimental condition, ten impressions were obtained according to table I. For the cast production at the pre-determined time, type IV gypsum [21] (Herostone, Vigodent, Petrópolis, RJ, Brazil) was manually mixed at a ratio of 50 g:11 ml, according to the manufacturer's instructions, by the same operator, with a 45-minutes wait for crystallization of all casts.

Table I – Material group, disinfection, storage time and number of samples in each experimental group

Group	Material	Disinfection	Storage time	n
Cs0	Cavex ColorChange	Without	Immediate	10
Cs1	Cavex ColorChange	Without	24 hours	10
Cs3	Cavex ColorChange	Without	72 hours	10
Cs5	Cavex ColorChange	Without	120 hours	10
Cc0	Cavex ColorChange	With	Immediate	10
Cc1	Cavex ColorChange	With	24 hours	10
Cc3	Cavex ColorChange	With	72 hours	10
Cc5	Cavex ColorChange	With	120 hours	10
Js0	Jeltrate Plus	Without	Immediate	10
Js1	Jeltrate Plus	Without	24 hours	10
Js3	Jeltrate Plus	Without	72 hours	10
Js5	Jeltrate Plus	Without	120 hours	10
Jc0	Jeltrate Plus	With	Immediate	10
Jc1	Jeltrate Plus	With	24 hours	10
Jc3	Jeltrate Plus	With	72 hours	10
Jc5	Jeltrate Plus	With	120 hours	10

After the gypsum had crystallized, the models were separated from the impressions with a single movement parallel to the insertion axis and the linear dimensional differences between the inter-abutment distances were measured with an electronic caliper (Mitutoyo 500-752-10, Tokyo, Japan), three repeated measurements were carried out, and the mean of the three measurements was obtained [21] (Kappa = 0.82).

Data were analyzed using SPSS 19 software (IBM Company, Armonk, NY, USA) with a statically significant level set at $P < .05$. The normality and homogeneity of the variances were tested by the Shapiro and Wilk [27] test and Levene's test, respectively. Three-way ANOVA was applied (alginate vs disinfection vs time), followed by Tukey's test ($\alpha < 0.05$).

Results

The results (table I) revealed that there was no statistically significant difference ($P > 0.05$) in disinfection for the same material and time (Cavex ColorChange or Jeltrate Plus). However, when Jeltrate was compared to Cavex at each of the storage times, differences were found only for 120 h/without disinfection ($P = 0.001$).

When we compared each alginate and storage time, a difference was found between the Jeltrate Plus groups ($P < 0.001$), revealing material alteration after 24-hour storage time, regardless of whether or not samples were submitted to the disinfection process. For the remaining storage times tested (72 and 120 h), we found no significant differences between groups, regardless of disinfection (Jc3, Jc5, Js3 e Js5).

With regard to Cavex ColorChange with disinfection at all storage times (Cc0, Cc1, Cc3 e Cc5), there was material alteration within 24 h ($P < .05$), whereas among the groups that were not disinfected, the alteration occurred only in the 72-hour storage time samples ($P < 0.001$), but was not statistically significant in the immediate and 24-hour storage groups ($P = 0.758$), similar to the Jeltrate groups, regardless of disinfection.

Table I – Linear dimensional stability of the groups (Jeltrate and Cavex ColorChange) regarding disinfection

Alginate	Disinfection	Storage time			
		Immediate	24h	72h	120h
Jeltrate	With	16.04 ± 0.06^{aA}	16.03 ± 0.03^{aA}	15.93 ± 0.03^{aB}	15.94 ± 0.05^{aB}
	Without	16.05 ± 0.05^{aA}	16.03 ± 0.5^{aA}	15.92 ± 0.05^{aB}	15.94 ± 0.06^{aB}
Cavex	With	16.00 ± 0.04^{aA}	16.04 ± 0.04^{aB}	15.97 ± 0.04^{aA}	15.98 ± 0.03^{aA}
	Without	16.02 ± 0.06^{aA}	16.03 ± 0.06^{aA}	15.92 ± 0.08^{aB}	16.02 ± 0.05^{aA}

* Different lower case letters indicate statistically significant differences between samples in the same column. Different uppercase letters indicate statistically-significant differences between samples in the same row

Discussion

The results led to the rejection of null hypothesis 1 since the Jeltrate Plus groups after 72 and 120 h of storage presented statistically significant differences, as did the Cavex ColorChange groups after 24 h of storage. However, null hypothesis 2 was accepted since all groups exhibited similar behavior at all time-points after disinfection.

In order to plan and develop reliable prosthetic work, the alginate to be used has to faithfully reproduce mouth and dental elements. In addition, the material must maintain dimensional stability until gypsum pouring. It is a matter of concern whether the disinfection might compromise such stability. According to the Brazilian Health Ministry [3], carrying out dental impression disinfection is necessary before the impressions can be sent to laboratories. The main infection transmission route from the patient to the dental technician occurs via contaminated impressions [13].

Sodium hypochlorite 1% has extensive virucidal and bacterial spectra with effective action against hepatitis B, *Mycobacterium tuberculosis* and HIV after treatment for 10 minutes [22]. The effectiveness of spray disinfection and sodium hypochlorite 1% was demonstrated by Linhares *et al.* [16] in a clinical test in which they observed that of 176 impressions, only 2.27% did not present any contamination after being washed in running water. However,

when the authors applied sodium hypochlorite 1% the result increased to 95.45% contamination-free impressions. The dimensional stability of alginate after spray disinfection using sodium hypochlorite 1% was demonstrated by Rueggerberg *et al.* [24] with immersion disinfection resulting in dimensional alteration. The results of this study confirmed literature reports. However, the reported studies evaluated the influence of disinfection only for immediate generated casts.

The immediate pouring of alginate impressions is known to be an important factor for dimensional stability; however, reality shows that it is not always possible, and if the material can withstand a certain storage time, the professional is helped considerably, conferring a great clinical advantage [28]. According to Imbery et al. [14], materials should present properties such as precision and dimensional stability, which should not change with cleaning, disinfection or storage procedures. Lemos *et al.* [15] observed that alginate did not suffer dimensional changes when immediate pouring occurred. This statement was confirmed in the present study, in which there were no significant differences between any material with or without disinfection when cast production was immediate. Shaba *et al.* [26] indicated that the ideal time to obtain models is 10 minutes.

In this study, Cavex ColorChange with immediate pouring differed to the same material after 24 h, when sodium hypochlorite 1% was employed, contrary to the results reported by Guiraldo *et al.* [11]. However, the same material, without disinfection only presented dimensional changes after storage for 72 h, demonstrating that there are other interfering factors that might alter the performance of these materials, such as the results found by Wadhwa *et al.* [29]. Previous studies have stated that the dimensional stability of alginate is multi-factorial [14, 28] and can be related to the storage time and conditions of the material constituents, or even to the pH during the gelation reaction. There is little available information on the factors related to the dimensional stability of new extended-pour alginates. Storage conditions are known to be significant [28], therefore the impressions in this study were stored in an environment with 100% humidity and at room temperature (20°C ± 5°C).

Guiraldo *et al.* [11] observed that disinfection does not alter the impression material when the option is immediate pour, this was also observed in this study, in which impressions with immediate pouring did not present significant changes. However, our results suggest that disinfection may alter the dimensional stability of Cavex at different pouring times, since the group disinfected showed alterations within 24 h, against 72 h for the non-disinfected group. The Jeltrate groups, however, presented stability until late pouring (72 and 120 h).

Fernandes *et al.* [8] concluded that third-generation alginates present alteration similar to that of vinyl polysiloxane after 96 h of storage time; however, they suggested immediate pouring, confirmed by this study, because despite the alginates being latest generation material, statistical differences between the Cavex ColorChange (extended pour) groups were detected after 24 h of storage, with disinfection, as well as in the Jeltrate Plus (conventional) groups starting at 72 h [10, 11].

Nowadays, the literature results can be described as controversial. While some authors have defended immediate pouring [15, 25], storage for 10 minutes [26] or even 4 h when stored in medium humidity and 2 h in medium dryness [19], others have demonstrated that some alginate can be poured later [7, 23]. Our results demonstrated that Jeltrate Plus could be disinfected and poured up to 24 h after taking the impression without significant dimensional changes. On the other hand, Cavex ColorChange should be poured in a shorter period of time or else another disinfection process should be used.

In this study, Jeltrate Plus with 72 and 120 h of storage presented significant dimensional changes compared to the immediate and the 24-h groups. Regarding the Cavex ColorChange alginate, there was a statistically significant difference in the 24-h storage group, returning to dimensions similar to the initial ones at 72 and 120 h. These variations, with significant differences for the conventional alginates and with a tendency to return to the initial dimensions after 120 h for the extended pour, were previously detected by Imbery *et al.* [14], who considered that correct storage might produce impression dimensions stable enough for diagnostic models, acrylic device manufacturing, and possibly structures for removable partial prostheses.

Thus, although short pouring time is not deemed necessary for latest generation alginates, as they have extended pouring time, short storage time is still the ideal [18]. In addition, several variables should be considered as influencing the final result, such as those inherent in the mouth environment (such as presence of saliva or blood) and in storage conditions (temperature and humidity). The absence of such variables can be considered a limitation of this study and require evaluation in future clinical trials.

Conclusion

Within the limits of this study and based on the results obtained, the conclusions are:

• Disinfection with sodium hypochlorite 1% spray carried out according to the standards presented in the literature does not alter the linear dimensional stability of irreversible hydrocolloids for the same pouring time;

• Both materials were dimensionally stable for 24 hours, however Cavex ColorChange should not be subjected to sodium hypochlorite 1% disinfection to obtain the model within this timeframe;

• Storage time influences the material linear dimensional stability.

References

1. ADA Council on Dental Materials, Instruments and Equipment: disinfection of impressions. J Am Dent Assoc. 1996;122:110.

2. Amortadi N, Chadwick RG. Disinfection of dental impressions – compliance to accepted standards. Br Dent J. 2010 Dec;209(12):607-11.

3. Brasil. Ministério da Saúde. Secretaria de Assistência à Saúde. Controle de infecções e a prática odontológica em tempos de AIDS: manual de condutas. São Paulo; 2000.

4. Chen SY, Liang WM, Chen FN. Factors affecting the accuracy of elastomeric impression materials. J Dent. 2004;32:603-9.

5. Demajo JK, Cassar V, Farrugia C, Millan-Sango D, Sammut C, Valdramidis V et al. Effectiveness of disinfectants on antimicrobial and physical properties of dental impression materials. Int J Prosthodont. 2016;29:63-7.

6. Erbe C, Ruf S, Ferger P, Balkenhol M. Dimensional accuracy of orthodontic alginates under different storage conditions. J Dent Res. 2006;85.

7. Erbe C, Ruf S, Wostmann B, Balkenhol M. Dimensional stability of comtemporary irreversible hydrocolloids: humidor versus wet tissue storage. J Prosthet Dent. 2012;108:114-22.

8. Fernandes SL, Francisconi PAS, Francisconi LF, Manfredi GGP, Cavenago BC, Costa AU et al. Estabilidade dimensional linear de alginatos de última geração em função do tempo de armazenagem dos moldes. Innov Implant J Biomater Esthet. 2014;8:18-22.

9. Garcia AR, Souza V, Pellizzer EP, Zuim PRJ, Passos CLA. Alterações dimensionais produzidas em modelos de gesso decorrentes da imersão do molde de alginato em soluções desinfetantes. Rev Odontol UNESP. 1995;24:271-80.

10. Guiraldo RD, Borsato TT, Berger SB, Lopes MB, Gonini Jr A, Sinhoreti MA. Surface detail reproduction and dimensional accuracy of stone models: influence of disinfectante solutions and alginate impression materials. Braz Dent J. 2012;23:417-21.

11. Guiraldo RD, Moreti AF, Martinelli J, Berger SB, Meneghel LL, Caixeta RV et al. Influence of alginate impression materials and storage time on surface detail reproduction and dimensional accuracy of stone models. Acta Odontol Latinoam. 2015;28:156-61.

12. Hansen P, Franco R, Beatty M. Wax lining in an impression tray and accuracy in gypsum cast fabrication. J Prosthodontics. 2016;25:44-8.

13. Hiraguchi H. Effect of storage period of alginate impressions following spray with disinfectant solutions on the dimensional accuracy and deformation of stone models. Dent Mater J. 2005;24:36-42.

14. Imbery TA, Nehring J, Janus C, Moon PC. Accuracy and dimensional stability of extended-pour and conventional alginate impression materials. J Am Dent Assoc. 2010;141:32-9.

15. Lemos IS, Porto RO, Alves BA, Jassé FF, Galvão MR, Andrade MF et al. Evaluation of the dimensional alteration of casts obtained from impressions with a traditional irreversible hydrocolloid and an antimicrobial one. Rev Odontol UNESP. 2010;39:41-7.

16. Linhares SMS, Maciel RMV, Silva ACP, Rozario HH, Gallito MA. Desinfecção de moldagens na Clínica Integrada da Faculdade de Odontologia de Campos. Rev Flum Odontol. 2010;16:36-42.

17. Nallamuthu N, Braden M, Oxford J, Willians D, Patel M. Modification of pH conferring virucidal activity on dental alginates. Materials. 2015;8:1966-75.

18. Nassar U, Aziz T, Floress-Mir C. Dimensional stability of irreversible hydrocolloid impression materials as a function of pouring time. A systematic review. J Prothet Dent. 2011;106:126-33.

19. Nassar U, Hussein B, Oko A, Carey JP, Flores-Mir C. Dimensional accuracy of 2 irreversible hydrocolloid alternative impression material with immediate and delayed pouring. J Can Dent Assoc. 2012;78:1-8.

20. Oderinu OH, Adegbulugbe IC, Shaba OP. Comparison of the dimensional stability of alginate impressions disinfected with 1% sodium hypochlorite using the spray or immersion method. Nig Q J Hosp Med. 2007;17:69-73.

21. Oliveira AR, Joias RM. Dimensional evaluation of molds of irreversible hydrocolloid after disinfection. Odonto. 2009;17:54-62.

22. Pedrosa NLM, Abreu JAFC, Lancellotti AC, Sinhoreti MAC, Gonçalves LS. Effect of different disinfection techniques on the accuracy of alginate impressions evaluated on stone casts. RFO UPF. 2012;17:285-9.

23. Rohanian A, Shabestari GO, Zeighami S, Samadi MJ, Shamshiri AR. Effect of storage time of extended-pour and convencional alginate impressions on dimensional accuracy of cast. J Dent. 2014;11:655-64.

24. Rueggerberg FA, Bealfe FE, Kelly MT, Schuster GS. Sodium hydroclorite disinfection of irreversible hydrocolloid impression material. J Prosthet Dent. 1992;67:628-31.

25. Sedda M, Casarotto A, Raustia A, Borracchini A. Effect of storage time on the accuracy of casts made from diferente irreversible hydrocolloids. J Contemp Dent Pract. 2008;1:59-66.

26. Shaba OP, Adegbulugbe IC, Oderinu OH. Dimensional stability of alginate impression material over a four hours time frame. Nig Q J Hosp Med. 2007;17:1-4.

27. Shapiro SS, Wilk MB. An analysis of variance test for normality. Biometrika. 1965;52:591-611.

28. Tood JA, Oesterle LJ, Newman SM, Shellhart WC. Dimensional changes of extended-pour alginate impression materials. Am J Orthod Dentofacial Orthop. 2013;143:555-63.

29. Wadhwa SS, Mehta R, Duggal N, Vasudeva K. Effect of pouring time on the dimensional accuracy of casts made from diferente irreversible hydrocolloid impression materials. Contemp Clin Dent. 2013 Jul;4:313-8.