

ANALYSIS OF THE DIMENSIONAL STABILITY OF EXTENDED-STORAGE IRREVERSIBLE HYDROCOLLOIDS

ANÁLISE DA ESTABILIDADE DIMENSIONAL DE HIDROCOLÓIDES IRREVERSÍVEIS COM TEMPO PARA VAZAMENTO ESTENDIDO

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ABSTRACT

The dimensional stability of alginates is poor when comparing to others materials and they should be poured immediately. The manufactures have launched new alginates, called extended-storage alginates, that purpose to be poured up to 5 days. The aim of this study was to evaluate the dimensional stability of two alginates dimensional stable (Cavex ColorChange and Hydrogum 5) and to do a comparative analysis with a conventional alginate (Jeltrate Plus). Materials and methods: It was used a standard model of acrylic resin representing an upper dental arch. Eight impressions were made for each alginate and three different storage times were used: 30 minutes, 48 hours and 96 hours. The distance between two parallels and fixed points in the molds were measured to analyze the dimensional change. The data was analyzed using SPSS 20.0 for windows.

The level of significance was set at $\alpha=0,05$. Results: For Cavex ColorChange and Hydrogum 5 alginates there was no statistically significant difference between the different storage times ($p>0.05$). Jeltrate Plus alginate suffered significant dimensional changes in different storage times. Although this study showed the delay to pour the mold for Hydrogum 5 and Cavex ColorChange, one can not neglect the care they require including adequate proportion of dust and water and keep the mold under good conditions of moisture. Conclusion: The results suggest that alginates Cavex ColorChange and Hydrogum 5 can be poured on up 96 hours and Jeltrate Plus should be poured immediately.

KEYWORDS: Alginates; Dental impression materials; Dimensional stability.

INTRODUCTION

Alginate is an irreversible hydrocolloid largely used in dentistry¹ and its mainly importance is portrayed in the stage of diagnostic and planning in rehabilitation² and orthodontics^{1,3} because it is easy to manipulation, low cost and a comfort level for patients^{4,5}.

The dimensional stability of alginates is poor when comparing to others materials⁶. They tend to distort with time by the gain or loss of water in processes known as synerises and soaking and they should be poured immediately, not exceeding 30 minutes^{2,7-9}.

This limitation has put forward to the rise of new materials, extended-storage alginates or called as dimensional stable that purpose to be poured up to 5 days, including Cavex ColorChange, Cavex Holland BV, Haarlem, Netherlands and Hydrogum 5, Zhermack, River Edge, New Jersey, USA. This characteristic may have a considerable clinical importance because could make possible a longer time of work for the dentists. Furthermore, there are no clinical and laboratorial studies that assure those information.

The aim of this study was to evaluate the dimensional stability of two extended-storage alginates and to do a comparative analysis with a conventional alginate. The hypothesis that will not have significance difference in the dimensional stability of alginate dimensional stable when comparing to the conventional will be tested. The rejection criteria of null hypothesis was defined by significance level of 5% ($\alpha=0,05$).

MATERIALS AND METHODS

Materials

The alginate impression materials used in this study are presented in Table 1 and included one conventional alginate (Jeltrate Plus) and two extended-storage alginate materials (Hydrogum 5 and Cavex ColorChange).

Table 1 - Alginate materials tested in this study

Materials	Trademark
Jeltrate Plus	Dentsply Latin American, Petrópolis, Brazil
Hydrogum 5	Zhermack, River Edge, New Jersey, USA
Cavex ColorChange	Cavex Holland BV, Haarlem, Netherlands

Methods

It was used a standard model of acrylic resin (Vipi Flash, Vipi, Pirassununga, Brazil), representing an upper dental arch. On the palate face of the first molars were fixed with acrylic resin, steel blades (TDV Dental, Santa Catarina, Brazil) (5x5x0.4mm) parallel to each other, leaving 0.5 mm above the palatal cusps. For a better view of the mold making, seconds before make the impressions the upper surface of the slide was stained with copy pencil

(Faber-Castell, São Carlos, Brazil). Plastic trays, number 4 (Maquira Dental Products, Maringá, Brazil) were used to make the impressions. The internal space for the impression material has been standardized through a wall of laboratory silicone (Zhermack, River Edge, New Jersey, USA) round the base of the standard model, creating stable stops for the impression trays, seating in a accurate reproducible position and a trajectory with single insertion.

Two scoops of alginate were used for each impression, using the scoop provided by each manufacturer and the necessary amount of water was measured with disposable syringe. The alginate powder was folded into the water and mixed manually, respecting the time of mix to each manufacture. The mixed was done by only one operator. Then the operator loaded the impression material into the plastic tray and seated the tray on the model until it rested firmly against the stop made with laboratory silicone. After the gel time recommended by manufacture the tray was removed in one direction and stored in a humid chamber. Eight impressions were made for each alginate and three different storage times were used: 30 minutes, 48 hours and 96 hours.

To evaluate the dimensional change/stability of molds, images were obtained through the digital camera with 100mm lens and MR-14EX macro ring flash (Rebel XTi, Canon Inc., Tokyo, Japan) stabilized on a tripod (Mattedi, Rio de Janeiro, Brazil) and positioned at a standard distance. The images were obtained immediately (30min), 48h and 96h after the impression. The distance between two parallels and fixed points in the molds were measured to analyze the dimensional change. The software Image J (National Institute of Mental Health Bethesda, Maryland, EUA) was used to give the distance between the points in the molds. To reduce human error and increase precision, the operator measured and recorded the distance three times for each image to calculate the mean. The measurement was done by only one operator.

Specimens of each material were subjected to Scanning Electron Microscope (Jeol JSM-6610, EUA) with EDX attached module to evaluate its composition. The data was analyzed using the software NSS X-ray microanalysis Thermo Scientific.

The results of Hydrogum 5 and Cavex ColorChange were tested using statistical analysis of variance of a factor (one-way ANOVA), considering that the data presented to the bow grip normal. As there was no normal distribution of data Jeltrate Plus, was applied Kruskal-Wallis non-parametric test. The data was analyzed using SPSS 17.0 for windows. The level of significance was set at $\alpha=0,05$.

RESULTS

For Cavex ColorChange ($p=0.37$) and Hydrogum 5 ($p=0.06$) alginates (Table 2) there was no statistically significant difference between the different storage times ($p>.05$), indicating the possibility of poured mold in period to 96 hours.

Table 2 - Mean (SD) of alginate impressions at three storage times

Alginate	Storage time		
	30 min	48 h	96 h
Hydrogum 5	31.61 (0.16)	31.63 (0.16)	31.40 (0.26)
Cavex ColorChange	31.80 (0.28)	31.99 (0.28)	31.95 (0.17)
Jeltrate	31.99 (0.18)	31.69 (0.21)	31.40 (0.12)

On the other hand, Jeltrate Plus alginate suffered significant dimensional changes in different storage times. There is an evidence of poor dimensional stability of this material, signaling the need for poured immediate.

Figure 1 with EDX analyzes show the presence of elements Oxygen, Silica, Calcium, Potassium, Aluminum and Titanium although with a uneven distribution in the materials. Silica was found in better proportions in Cavex ColorChange and Hydrogum 5.

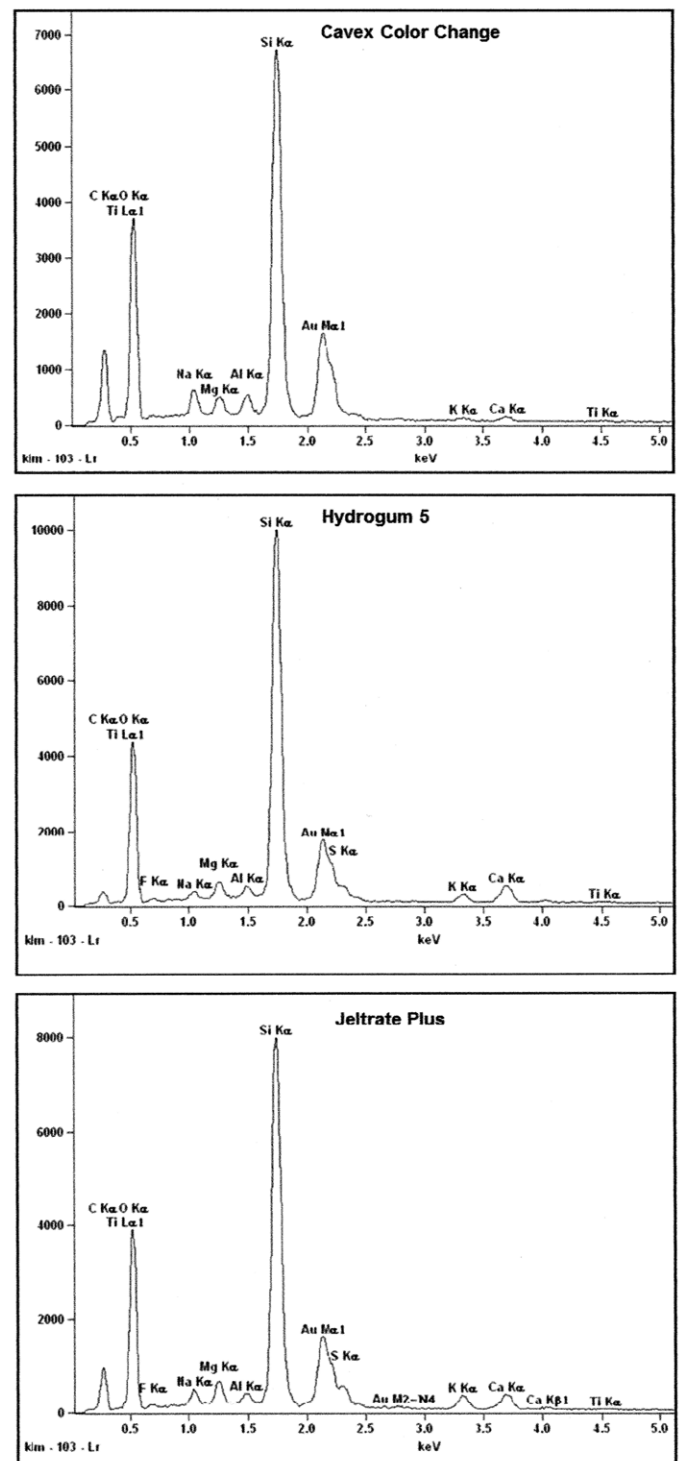


Figure 1 - EDX analyzes showing the composition of alginates

DISCUSSION

The dimensional stability of a material is the ability to keep accurate and precise over the time¹⁰, a critical characteristic that applies to irreversible hydrocolloids to undergo syneresis and/or soaking when subjected to minor changes of humidity and temperature. The alginates have low dimensional stability⁶ and the casting mold should be immediate^{2,7,8} which represents a disadvantage and limits the clinical indication to diagnostic and study procedures.

Hydrogum 5 and Cavex ColorChange, alginates tested in this study remained dimensionally stable over 96 hours and this result corroborates findings in other studies that suggested casting mold up to 5 days for dimensionally stable alginate^{1,10,11}. As for the Jeltrate Plus, conventional alginate, there was evidence of poor dimensional stability and its immediate casting, not exceeding 30 minutes, is still necessary^{1,6,11}. Although this study suggests the delay to cast the mold for Hydrogum 5 and Cavex ColorChange, one can not neglect the care they require including adequate proportion of dust and water and keep the mold under good conditions of moisture. The null hypothesis "there is no difference in dimensional stability among extended-storage and conventional alginates" was rejected for Jeltrate Plus conventional alginate.

It is not known what modifications were made in the compositions of alginates to increase the dimensional stability. In the present study silica was found in better proportions in Cavex ColorChange and Hydrogum 5, which may suggest the high concentrations of this element with improved dimensional stability, however in another study titanium and fluorine was found in Hydrogum 5, suggesting too a possible association of these elements with dimensional stability¹². Studies have observed improves dimensional stability in alginates containing higher levels of alginic polymer and lower molecular weight polymer chain¹³. Despite did not study the influence of additives that control the pH of chromatic alginates, such as Cavex ColorChange, Imbery¹⁰ et al. (2010) argue that such additives can have a beneficial role. Although there are some studies that attempted to study changes in newer alginates, changes in chemical compositions are not yet fully elucidated, especially as regards improvement of the dimensional stability of these materials. So, there is still a scientific gap regarding the changes made in the alginate to improve the dimensional stability that must be filled.

To reduce the variables of this in vitro study, the molds were not submitted to any disinfection and cast process. Although not reporting a real clinical situation, the results suggest the delay of cast the molds and this represents an important step forward for dentistry with regard to the use of dimensionally stable alginate for optimal clinical time and more researches should be done to investigate others characteristics of extended poured alginates in clinical conditions.

CONCLUSIONS

Within the limitations of this study can be concluded that only Cavex ColorChange and Hydrogum 5 alginates can be poured on up 96 hours. On the other hand, the Jeltrate Plus alginate should be poured immediately.

REFERENCES

- Walker MP, Burckhard J, Mitts DA, Williams KB. Dimensional change over time of extended-storage alginate impression materials. *Angle Orthod.* 2010; 80(6): 1110-5.
- Sedda M, Casarotto A, Raustia A, Borracchini A. Effect of storage time on the accuracy of casts made from different irreversible hydrocolloids. *J Contemp Dent Pract.* 2008; 9(4): 59-66.
- Torassian G, Kau CH, English JD, Powers J, Bussa HI, Marie Salas-Lopez A, et al. Digital models vs plaster models using alginate and alginate substitute materials. *Angle Orthod.* 2010; 80(4): 474-81.
- Rudd KD, Morrow RM, Strunk RR. Accurate alginate impressions. *J Prosthet Dent.* 1969; 22(3): 294-300.
- Fokkinga WA, Witter DJ, Bronkhorst EM, Creugers NHJ. Clinical fit of partial removable dental prostheses based on alginate or polyvinyl siloxane impressions. *Int J Prosthodont.* 2017; 30(1): 33-7.
- Rubel, BS. Impression materials: a comparative review of impression materials most commonly used in restorative dentistry. 2007; 51(3): 629-42.
- Cohen BI, Pagnillo M, Deutsch AS, Musikant BL. Dimensional accuracy of three different alginate impression materials. *J Prosthodont.* 1995; 4(3): 195-9.
- Powers JM, Sakaguchi RL. Impression materials. In: Craig's Restorative Dental Materials. 12 ed. St. Louis: Mosby; 2006. p. 269-312.
- Jiang T, Lee SM, Hou Y, Chang X, Hwang HS. Evaluation of digital dental models obtained from dental cone-beam computed tomography scan of alginate impressions. *Korean J Orthod.* 2016; 46(3): 129-36.
- 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(1): 32-9.
- Nassar U, Aziz T, Flores-Mir C. Dimensional stability of irreversible hydrocolloid impression materials as a function of pouring time: a systematic review. *J Prosthet Dent.* 2011; 106(2): 126-33.
- Wandrekar S, Juszczak AS, Clark RK, Radford DR. Dimensional stability of newer alginate impression materials over seven days. *Eur J Prosthodont Restor Dent.* 2010; 18(4): 163-70.
- Fellows CM, Thomas GA. Determination of bound and unbound water in dental alginate irreversible hydrocolloid by nuclear magnetic resonance spectroscopy. *Dent Mater.* 2009; 25(4): 486-93.

RESUMO

A estabilidade dimensional dos alginatos é baixa quando comparada com outros materiais e eles devem ser vazados imediatamente. Novos alginatos foram lançados no mercado, denominados de "armazenagem estendida", que se destinam a ser vazados em até 5 dias. O objetivo deste estudo foi avaliar a estabilidade dimensional de dois alginatos dimensionalmente estáveis (Cavex ColorChange e Hydrogum 5) e realizar uma

análise comparativa com um alginato convencional (Jeltrate Plus). Material e método: Foi utilizado um modelo padrão de resina acrílica representando um arco dentário superior. Foram feitas oito impressões para cada alginato e utilizados três tempos de armazenamento: 30 minutos, 48 e 96 horas. A distância entre dois pontos fixos e paralelos nos moldes foi medida para analisar a alteração dimensional. Os dados foram

analisados utilizando o SPSS 20.0. O nível de significância foi estabelecido em $\alpha=0,05$. Resultados: Para os alginatos Cavex ColorChange e Hydrogum 5 não houve diferença estatisticamente significativa entre os diferentes tempos de armazenamento ($p>0,05$). O alginato Jeltrate Plus sofreu alterações dimensionais significativas nos diferentes tempos de armazenamento. Embora este estudo mostrou um ganho de tempo para vaziar o molde para Hydrogum 5 e Cavex ColorChange,

não se pode negligenciar o cuidado que necessitam incluindo proporção adequada de pó e água e manter o molde em boas condições de umidade. Conclusão: Os resultados sugerem que os alginatos Cavex ColorChange e Hydrogum 5 podem ser vertidos em até 96 horas enquanto o Jeltrate Plus deve ser vazado imediatamente.

PALAVRAS-CHAVE: Alginatos; Materiais de moldagem; Estabilidade dimensional.

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