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HORIZONTAL DIMENSIONAL DEVIATIONS IN PLASTER CASTS TAKEN WITH ALGINATE WITH DIFFERENT CHEMICAL COMPOSITION

ХОРИЗОНТАЛНИ ОТСТАПУВАЊА ВО ДИМЕНЗИИТЕ НА ГИПСЕНИ МОДЕЛИ ЗЕМЕНИ СО АЛГИНАТИ СО РАЗЛИЧЕН ХЕМИСКИ СОСТАВ

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Abstract

Introduction: The dimensional stability of impression materials and plaster has the highest impact on working models precision and stability. **The Aim** of this article was to measure and compare linear dimensional changes of three alginate materials after immersion in disinfectant for a certain period of time. **Materials and Method:** To achieve the purpose of the examination, we included a physical standard, from which impression were taken and plaster casts were made. Depending on the alginate type, three groups were made: group I – standard type alginate, group II – alginate enriched with phosphate particles, group III – alginate with disinfectant. Within these three groups, three subgroups were formed: subgroup I (control) – non disinfected impressions, cast with hard plaster 30 minutes after taking the impression; subgroup II – impressions immersed 15 minutes in 0.5% sodium hypochlorite; subgroup III – impressions immersed 30 minutes in 0.5% sodium hypochlorite. After the completed disinfection, the impressions were cast with plaster and the linear distances between the defined points on the models were measured using a digital micrometer with measurement capacity up to the second decimal. The obtained values and determined linear variations were statistically analyzed in further research. **The Results** of the tests showed that the method of immersing three different alginate impression materials for 15 and 30 minutes, do not cause significant linear dimensional changes, and clinically negligible. **Conclusion:** Short term immersion in a disinfectant, from 15 to 30 minutes, is an acceptable method for disinfecting alginate impressions without significant dimensional changes occurring. **Key words:** alginate, disinfection, dimensional changes.

Апстракт

Вовед: Димензионалната стабилност на масите за отпечатување и на гипсот имаат најголемо влијание на прецизноста и стабилноста на работниот модел. **Целта** на овој труд беше да се измерат и споредат линеарните димензионални промени на три алгинати со различен состав по потопување во дезифициенс во одреден временски интервал. **Материјал и метод:** За реализација на целите во испитувањето вклучивме изработка на физички еталон од кој се земени отпечатоците и излеани гипсени модели. Според видот на алгинатот конципиравме три групи: I група – алгинат, стандарден по состав, II група - алгинат збогатен со фосфатни честички и III група - алгинат со дезинфициенс. Во рамките на секоја од овие три групи формирани се три подгрупи: подгрупа 1 (контролна група) недизинфицирани отпечатоци излеани со тврд гипс 30 минути по земање на отпечатокот, втора подгрупа отпечатоци потопени 15 минути во 0,5% натриум хипохлорит и трета подгрупа отпечатоци потопени 30 минути во 0,5% натриум хипохлорит. По завршената дезинфекција отпечатоците се излеани со гипс и на моделите извршивме мерења на линеарните растојанија помеѓу дефинирани точки со дигитален микрометар со капацитет на мерност до втората децимала. Добиените вредности и детерминираните линеарни варијации во натамошното истражување беа стастистички анализирани. **Резултатите** од испитувањата покажаа дека методот на потопување на отпечатоците земени со трите вида алгинат во времетраење од 15 и 30 минути не предизвика значајни линеарни димензионални промени, односно се занемарливи од клинички аспект. **Заклучок:** Краткотрајното потопување во дезинфекционо средство од 15 до 30 минути е прифатлив метод за дезинфекција на отпечатоците земени со алгинат без да се појават значајни димензионални промени. **Клучни зборови:** алгинат, дезинфекција, димензионални промени.

Introduction

Dental impressions are potential sources for bacterial contamination. At the same time the possibility of contamination with pathogenic microorganisms is high, and the impression materials that are exposed to infected saliva or blood can become the main source of infection[1,2,3]. Various chemicals have been used to disinfect dental impressions, such as: sodium hypochlorite, glutaraldehyde, chlorhexidine, iodophor, peracetic acid and mixed disinfectants[4].

Sodium hypochlorite and glutaraldehyde are the most commonly used disinfectants[2,5,6]. Several authors have used sodium hypochlorite in a 2% concentration to disinfect alginate, including Badrian et al.[7], Porrelli et al.[8], Rentzia et al.[9] and Lorson et al.[10]. The basic requirement is that the disinfection lasts as short as possible and to not affect the dimensional stability of the impression. However, there might be side effects associated with the disinfection process due to chemical or physicochemical interaction between the impression material and the disinfection solution[11]. Ghasemi et al.[12] examined the effect of disinfection on the dimensional changes of alginate impression materials using the spray method with 0.5% sodium hypochlorite as disinfectant for a period of 10 minutes and concluded that this method had no significant impact on the dimensions on plaster cast models. The effect of different disinfection systems on the dimensional stability of alginate and addition silicone impressions was compared by Samra and Bhide[13]. They recommend disinfection of these materials with sodium hypochlorite and an ultraviolet chamber. In their study, Babiker et al.[5] investigated the effect of 1% and 5.25% sodium hypochlorite, as spray and immersion solutions, on the dimensional accuracy of alginate impression material. In their study, Ulgey and Yesilyurt[14] determined the best approach to reduce adverse changes on alginate impressions in three different dimensions with disinfection duration of 15 and 30 minutes. They concluded that a 15-minute disinfection can provide favorable results to obtain all prints with minimal distortion. In their research, Altaf et al.[15], in 2020, compared the linear dimensional changes of alginate impressions disinfected by immersion in 0.525% sodium hypochlorite solution for 10 minutes. The authors concluded that disinfection by immersion in a 0.525% sodium hypochlorite solution had no significant effect on dimensional stability. Adding a disinfectant to alginate impression materials can eliminate the disinfection procedure, to avoid dimensional changes. The aim of the study by Amalan et al.[16] was to evaluate the effect of the alginate material containing disinfectant chlorhexidine (0.1 and 0.2%) and sodium hypochlorite (0.1 and 0.5%) on the dimensional stability. From the obtained results, we can conclude that the dimensional changes were below the limit of the material specification.

Aim

As a current problem, the protection of the dental team, as well as the proper production of prosthetic restorations, were the motive for setting the goal of this paper:

To measure and compare the linear dimensional changes of three different irreversible hydrocolloid materials (alginates) after immersion in disinfectant for different time intervals.

Material and method

In the research, we used alginate with standard composition, alginate with phosphate particles in the composition, and alginate with disinfectant. We used 0.5% sodium hypochlorite for disinfection.

To achieve the set goals, we used an acrylate master model for taking impressions and making plaster casts, for measurements and comparative analyses. Linear measurements were performed between precisely defined points on the palatal surface of the maxillary central incisors in the region of the cingulum. The master model was placed on a milling machine and with the help of a metal milling cutter, a cylindrical recess was made with an angle of 60 degrees with a point bottom and constant depth. The points are marked as point A and B. On the occlusal surfaces of the two first maxillary molars of the master model, the same cylindrical recesses were made in the middle of the central fissure. These points are marked as point C and D.

The horizontal linear distances between the points: A and B, A and C, C and D, D and B were measured. To

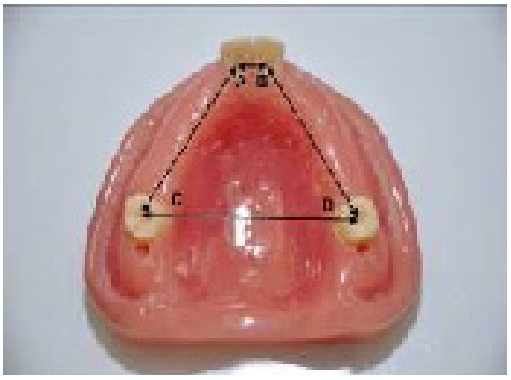

Figure 1. *Defined points for measuring horizontal distance*

Figure 2. *Measurement of horizontal distance*

realize and prove the goals of the research, three groups were defined: group I – standard irreversible hydrocolloid, group II – modified irreversible hydrocolloid enriched with phosphate particles, group III – irreversible hydrocolloid with disinfectant.

Within each of these three groups, three subgroups were formed. First subgroup – impressions were taken and rinsed with running water and cast with hard plaster 30 minutes after taking the impression (control group). Second subgroup – impressions kept in 0.5% sodium hypochlorite for 15 minutes and cast after 30 minutes. Third subgroup – impressions kept in 0.5% sodium hypochlorite for 30 minutes and cast with hard plaster 60 minutes after taking the impression. These three procedures were repeated for all three groups with different alginates, and for the realization of the tests, a total of 90 plaster casts were made (30 casts of each group). Measurements were performed with digital micrometer with measurement capacity up to the second decimal. The obtained values and determined linear variations in further research were statistically analyzed through: maximum value of measured distance, minimum value of measured distance, mean and average value of measured distance, standard deviation Kruskal Wallis, ANOVA test, Mann – Whitney test, t – test for independent samples, variance analysis, and Post hoc analysis Tukey HSD test.

Results

This part of the research shows the results obtained by processing and statistical analysis of data, obtained by measuring and comparing the linear dimensions (AB, AC, CD, DB) of the three different types of alginate impressions, and one reference model. The values of the descriptive measures for the length of the horizontal distances AB and AC on impressions from all three groups, and the reference model are shown in figures 3 and 4.

The values of descriptive measures for length of horizontal distances CD and DB in impressions from all

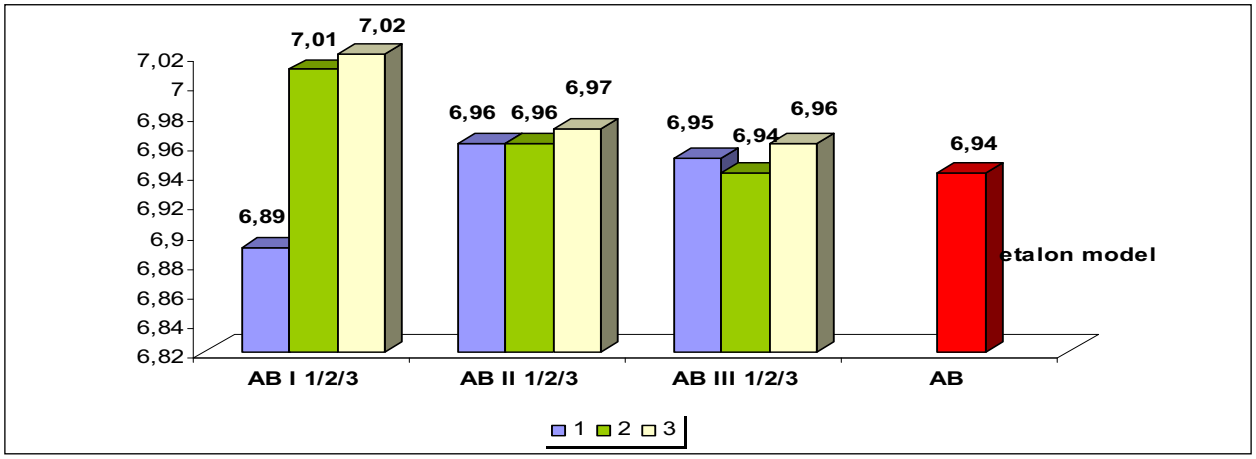

Figure 3. *Longitudinal horizontal distance AB*

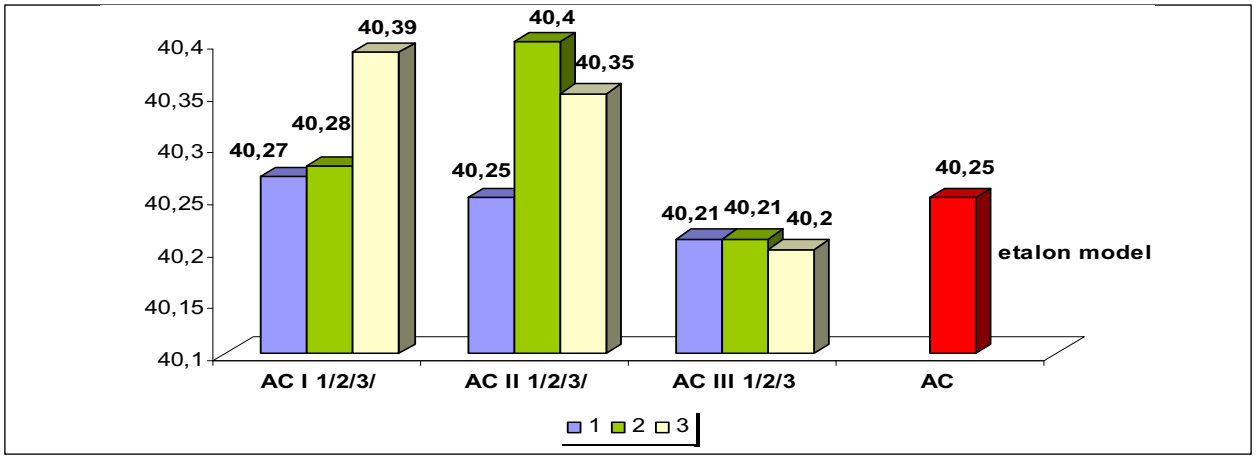

Figure 4. *Longitudinal horizontal distance AC*

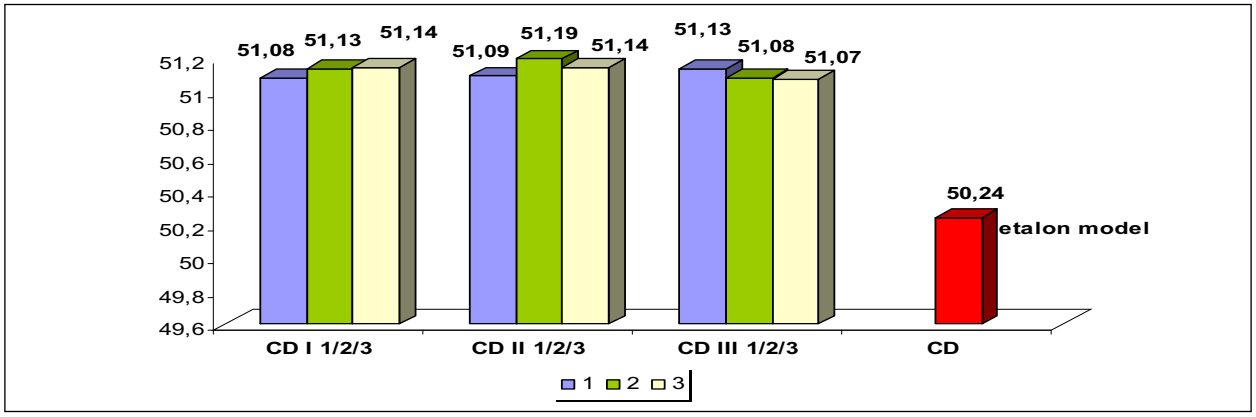

Figure 5. *Longitudinal horizontal distance CD*

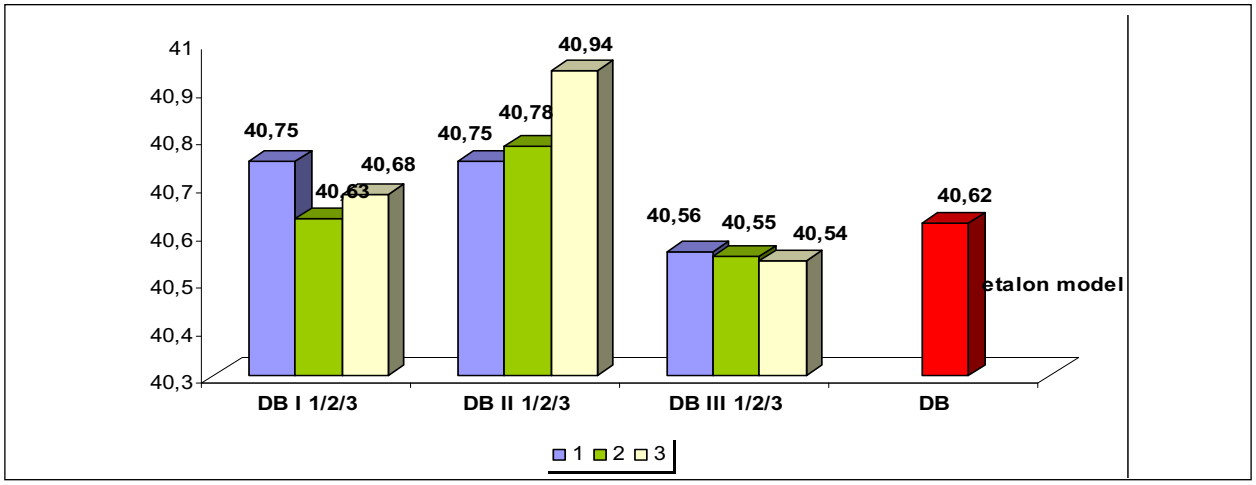

Figure 6. *Longitudinal horizontal distance DB*

Table 1. Results of tested differences between the analyzed groups of impressions.

Разлики меѓу групи	Mann-Whitney U					
	Rank Sum	Rank Sum	U	Z	p	Sig./N.Sig.
I/II	58596.0	56843.0	27923.5	0.58	0.56	N.Sig.
I/III	59624.0	55816.0	26896.0	1.25	0.21	N.Sig.
II/III	58822.0	56617.5	27697.5	0.73	0.47	N.Sig.

three groups, and the reference model are shown in figures 5 and 6.

The results of the tested differences between the analyzed groups of prints through the Mann – Whitney U test are shown in Table 1.

Discussion

The obtained results, by testing the differences in the average lengths AB, AC, CD and DB in the impressions taken with standard alginate that are not kept in solution

(control group), show smaller lengths of these distances compared to the impressions from the disinfected groups. The obtained values confirm the fact that disinfection by the immersion method has a significant influence on the linear changes of the alginate impression material. The immersion time plays an insignificant role in the water imbibitions process, in the appearance of the dimensional changes, after disinfection for a period of 15 and 30 minutes. This indicates that the optimal disinfection time is up to 15 minutes, a time during which the impression material is dimensionally stable. Our results correlate with the results of Ulgej et al.[14]. By examining the effect of immersion in a solution of sodium hypochlorite for a duration of 15 minutes, impressions with minimal dimensional changes are obtained. Similar results are presented by Wu HM et al.[17]. Babiker et al.[5]. In their study they investigated the effect of 1% and 5,25% sodium hypochlorite (NaOCl), as a spray and as an immersion solution, on the dimensional accuracy of alginate impression material. They indicate that it would be more appropriate to disinfect the impressions by spraying NaOCl solution rather than by immersion. Hiragushi et al.[18] investigated the dimensional changes of plaster casts, using the method of immersing alginate impressions in 0.5% sodium hypochlorite solution for 15 minutes. The differences in dimensional changes between casts from disinfected impression and non-disinfected ones were less than 15μm. Samra and Bhide[13] analyzed and compared the effect of different disinfection systems on the dimensional stability of commonly used alginate and addition silicone impression materials. They concluded that the tested materials could be safely disinfected with sodium hypochlorite for 10 minutes. Ismail et al.[19] examined the dimensional stability of alginate impressions by immersion in two different solutions (1% sodium hypochlorite and 2% glutaraldehide) for 10 and 60 minutes. They found that immersion in disinfectant for 10 minutes did not affect the dimensional stability. In their study, Ghasemi et al.[12], examined the effect of three disinfectants on the dimensional changes of alginate and additive silicone impression materials. Impressions are disinfected by the spray method for 10 minutes not including the control group. We can conclude that disinfection of alginate and addition silicone impressions with 0.5% sodium hypochlorite has no significant effect on the dimensions of the plaster casts. Altaf et al.[15] compared the changes in linear dimension of alginate impression by immersion in 0.525% sodium hypochlorite solution for 10 minutes, and determined that this immersion period did not cause significant changes on the dimensional stability of the impression. The stability of alginate impressions deteriorates over time due to water evaporation. Casting impressions immediately after taking provides the highest accuracy[20,21]. Alginate impressions have tendency to absorb water due to the differential osmotic pressure between the impression and the disinfecting solution[22,18]. Among the three subgroups of impressions taken with alginate with phosphate particles, the tested differences in the largest horizontal dimension (CD) were statistically insignificant ($p<0.05$). This means that in the impressions of modified alginate enriched with phosphate particles, we obtained the smallest and insignificant dimensional changes in relation to the measured horizontal distances. The largest part of alginate is water, therefore, any change in the amount of water has a significant impact on the properties of the materials or the accuracy of the impression. Guiraldo et al. and Hamedi et al.[4,22] indicate that disinfection does not significantly affect the dimensional integrity. Some researchers used self-disinfecting alginates and added solutions of chemical disinfectants when mixing the alginate. Benakatti et al.[23], investigated the effect of four commercially available alginate impression materials, that were mixed with disinfectant liquid containing chlorhexidine and sodium hypochlorite, on the properties. Alginate impression materials mixed with chlorhexidine expressed varying degrees of antibacterial activity without affecting dimensional stability. The values we obtained when determining the parameters in a linear direction, in correlation with the exposure time to disinfection in some conditions showed a statistical and in some insignificant difference, which gives us the right to conclude that 15 to 30 minutes is the time necessary for disinfection of impression materials that do not affect the precision and quality of the cast, and consequently the prosthetic restoration. In this paper we used three different alginates which, compared and statistically analyzed, did not show a statistically significant difference in relation to the linear deformation. Variations in subgroups generally do not affect different impression materials. With these values, we can safely say that conventional alginate is an impression material that can be used daily with a disinfection procedure.

Conclusion

Based on the measured values and parameters and their statistical analysis we can summarize the following: during the disinfection procedure, alginate impression materials show linear dimensional changes when immersed in a hypochlorite solution. Regardless of the time of exposure to the disinfectant solution, 15 or 30 minutes, conventional alginates do not demonstrate statistically significant differences in all dimensions. Short-term immersion in a disinfectant for 15 minutes is an acceptable method for disinfecting alginate impressions without significant dimensional changes and is clinically acceptable.

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